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MEMOIRS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT

HARVARD COLLEGE.

VOL. XLVI.

153805
31/12/19.

CAMBRIDGE, MASS., U. S. A.
Printed for the Museum.
1914–1917.

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THE COSMOS PRESS:

EDWARD W. WHEELER, CAMBRIDGE, MASS., U. S. A.

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Memoirs of the Museum of Comparative Zoölogy
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HAWAIIAN AND OTHER PACIFIC ECHINI.

THE CLYPEASTRIDAE, ARACHNOIDIDAE, LAGANIDAE, FIBULARIIDAE, AND SCUTELLIDAE.

BY

HUBERT LYMAN CLARK.

WITH TWENTY-TWO PLATES.

Plates 122–143.

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CAMBRIDGE, U.S.A.:
Printed for the Museum.
June, 1914.

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HAWAIIAN AND OTHER PACIFIC ECHINI.

Collected by the U. S. Fish Commission Steamer Albatross, Commander Chauncey Thomas, U. S. N., Commanding in 1902, and Lieut. Commander L. M. Garrett, U. S. N., Commanding in 1906.

CLYPEASTRINA Gregory.

General Characteristics.

Although closely related to the now extinct Holectypina, the suborder Clypeastrina is sharply marked off from all recent Echini by the form of the test, the position of the periproct, the presence of jaws and auricles, in the absence of peristomal gills, and the usually petaloid arrangement of the ambulacra aborally. Such a combination of characters gives them a general appearance which is usually easily recognizable and as they all resemble more or less closely the well-known species of the typical genus Clypeaster, they have come to be colloquially known as clypeastroids. The group is not only well defined and homogeneous but is a relatively small one and of comparatively recent geological appearance.

There is good ground for the belief that they arose in connection with the Holectypina from a stirodont group of regular Echini, of which the Arbaciidae are modern representatives. The evidence in support of this belief has been briefly set forth by Jackson (1912, Phylogeny of the Echini. Mem. Boston Soc. Nat. Hist., 7, p. 217). But it ought to be pointed out that the primary tubercles in *all* clypeastroids are *perforate*, while this is true of no Stirodonta save some of the fossil Saleniidae. This may be interpreted however, simply as the retention of an ancestral character, for it is found in all the primitive regular Echini.

The classification of the clypeastroids is based primarily upon the auricles, with which the well developed but characteristic lantern is associated. In the more typical and primitive members of the group, the auricles of each ambulacrum are not only distinct but are well separated from each other. In more specialized forms the right hand auricle of one ambulacrum and the left hand auricle of the adjoining ambulacrum have become more or less completely transposed on to the separating interambulacral plate and are more or less fused into a

single upright piece. This remarkable migration of the auricles is one of the most notable features of clypeastroid morphology, and divides the suborder into two distinct groups.

Another character of some importance is to be seen at the other end of the interambulacra. Here, where the interambulacrum adjoins the genital plate, there are usually two small plates to be seen side by side, terminating the two columns of interambulacral plates, as in regular Echini. But in some clypeastroids, one of this pair greatly outstrips the other in growth and comes ultimately to occupy the entire aboral end of the interambulacrum, increasing in size most disproportionately as the test grows. In other clypeastroids, the oral end of the interambulacrum may undergo a curious change during growth, by which the primordial interambulacral plate remains in the basicoronal row, but is separated from its fellows by the crowding in of ambulacral plates, making what is called a "discontinuous interambulacrum."

The shape of the test, the position of the anus, the number and position of the genital and madreporic pores, and the character of the buccal membrane are all characters of more or less importance. Probably the form of the test is very directly connected with the manner of life for it is known that the very flat, discoidal species live a strictly subarenaceous life while the higher, more "biscuit-shaped" species live *on* the bottom where they are only in part or not at all covered by sand. It must be admitted that we know almost nothing from actual observations as to the habits of these Echini, and possibly some assumptions as to the significance of certain test-forms are quite erroneous. Accompanying the flattening of the test, there has been a marked development of internal calcareous supports in the form of pillars, walls and horizontal floors. In some cases, as Echinocyanus, these appear early in development and undergo little change with age and are hence of systematic importance, but as a rule the deposit of this extra calcareous matter goes on for a long time, perhaps throughout life, and with varying rates in different individuals. The resulting features of internal structure are therefore very diversified and I have been unable to make any satisfactory use of these characters for systematic purposes, except in the Fibulariidae.

The occurrence of *lunules* or slits extending through the entire test, permitting the free passage of water between the oral and aboral surfaces, is a remarkable feature of many of the discoidal clypeastroids. The lunules may be either ambulacral or interambulacral in position but always lie with the long axis parallel to the radius of the test. They arise in the course of development, either as notches in the test margin which become deeper with the growth of the

test and ultimately are closed in at the distal end, or as depressions on the oral side of the test which by resorption ultimately perforate both the oral and aboral plates and attain to the full size of the lunule. But whether the two processes have developed simultaneously in phylogeny or whether one is more primitive than the other, is still unsettled. There are some reasons, however, for believing that the resorptive process was the first to occur and that the lunule of the posterior interambulacrum is the oldest phylogenetically. Practically nothing is known as yet as to the function of the lunules — granting that they have any. In certain genera, notably Rotula, marginal slits, which never close to form lunules, occur, particularly in the posterior interambulacrum and the adjoining ambulacra. Their use is as obscure as that of the lunules.

Another remarkable feature of the clypeastroids is the extension of the ambulacral tube-feet on to other portions of the test than the strictly "poriferous areas" of the ambulacra. The modification of the aboral part of the ambulacra to form the characteristic "petals" is so well known, no description of it is necessary here, though the form of the petals and certain details of their structure are of great systematic importance. But the occurrence of a multitude of very minute ambulacral feet is not so generally known. Mr. Agassiz (1874, Rev. Ech., pt. 4, p. 695) has described the distribution of these supernumerary pedicels in several genera, and Miss Gregory (1911, Zool. Anz., **38**, p. 323) has given a detailed account of them, as seen from the interior of the test, in Echinarachnius. There is, however, much still to be learned in regard to their distribution in the different genera. The resemblance between the distribution of the pedicels in Echinarachnius and in such holothurians, as Thyone, is a most striking example of "parallelism," the genetic connection between the two groups being of course very indirect. Associated with this multiplication of pedicels in the clypeastroids is the development of what are called the "ambulacral furrows," grooves on the outer surface of the oral side of the test, radiating out from the mouth and extending in the median ambulacral area towards the margin. They may be simple, short and indistinct, or simple (*i. e.* unbranched) and extending clearly to the margin, or branched more or less extensively and some or most of the branches reaching the margin. Their arrangement is a feature of some systematic importance.

The anus, or better the periproct, lies near the margin of the test in the posterior interradius. In young individuals it is more or less aboral in position and in adult Arachnoides, it is more aboral than oral. In several cases it is marginal, but most commonly it is distinctly on the oral surface. In extreme

cases, in the Scutellidae, it is not far from the mouth and in many genera its distance from the margin is an important specific character. Usually the periproctal plates carry miliary spines and sometimes pedicellariae, but in some species they are quite naked.

The genital pores vary in number, size, and position. In Clypeaster and some other genera, there are typically five pores and any other number is very rare even as an individual variant. These five pores are in the interradii at, or very near, the margin of the fused oculogenito-madreporic body. In the Laganidae, the number of pores may be either four, five, or six and they may lie far down in the interradii instead of near the abactinal system. When six pores are present, there are two in the posterior interradius. In the other families the number of pores is commonly four but five is characteristic of some genera. The number and position of the ocular pores shows so little diversity that they are of no use for systematic purposes. There are always five and they lie close to the margin of the oculogenito-madreporic body.

The madreporic pores are usually numerous and occupy most of the surface of the plate formed by the fusion of the oculars and genitals; for this reason I have called this plate the oculogenito-madreporic body. In the recent Fibulariidae there is only a single madreporic pore and it is conspicuously large. This is a useful systematic character and is of great help in distinguishing these little clypeastroids from young Clypeasters, for the latter have at least several madreporic pores even when only a few millimeters long. It should be noted however that *Fibularia nigeriae* Hawkins, a Tertiary species, is said to have numerous madreporic pores.

In addition to the tubercles which bear spines and pedicellariae, the tests of many clypeastroids bear low rounded elevations, known as "glassy tubercles." These take their name from the fact that they are composed of an unusually dense carbonate of lime, which is clear and transparent and thus, when cleaned from the overlying epidermis, resembles glass. The function of these tubercles is not known and their use for systematic purposes is very slight.

The buccal membrane in clypeastroids is generally thin and lacks calcareous matter but Arachnoides is exceptional in that there are distinct plates on the membrane, which carry miliary spines. The same seems to be true of Rotula, though the available material of this genus is too poor for a satisfactory determination of the point.

The Spines, Pedicellariae, Sphaeridia, and Spicules.

Plates 122–125.[1]

In all clypeastroids the test is densely covered with spines. Occasionally one can distinguish *three* very distinct sizes of spines, which might be called primaries, secondaries, and miliaries, but since these so-called primaries are present in very few species and are not surrounded by circles of secondaries, it has become a general custom to speak of the spines of clypeastroids as "primaries" and "miliaries" only, the term "secondary" not being used. We therefore speak of the conspicuous spines in such species as *Clypeaster lamprus* as "large primaries." Occasionally one finds the term "secondary" but it is used simply as a synonym of miliary; thus de Meijere, in his notable account of the clypeastroids of the Siboga (1904, Siboga Echini, p. 103–139) occasionally refers to "secundärstacheln" but in every case the context shows that he means miliaries. It was due to his careful work that attention was first called to the characteristics of the miliary spines in the Laganidae and the striking difference there is between them and those of the Clypeastridae. Apparently de Meijere has gone too far in attempting to find specific and generic characters in the miliary spines, for examination of these spines from nearly all the known species of Laganidae has satisfied me that there is so much individual diversity and so much evidence of varying degrees of wear on the tips of these spines, that they are of little real value for specific distinctions. But the fact remains that the form and structure of the terminal portion of both primary and miliary spines in clypeastroids are characters of real importance in working out the interrelationships of the genera.

In all the genera, the primary spines are solid, but they may be either straight (Pl. 122, figs. *9*, *11*, *16*, *17*), curved (Pl. 122, figs. *12*, *14*) or bent (Pl. 125, fig. *16*); they may taper to a sharp point (Pl. 122, fig. *9*) or be quite blunt (Pl. 122, fig. *16*), or be flattened and chisel-like (Pl. 122, figs. *12*, *13*), or simply expanded (Pl. 122, fig. *1*) or be much swollen at the tip (Pl. 125, figs. *4*, *5*, *17*, *18*); they may be quite smooth (Pl. 122, fig. *16*) or serrated along one side (Pl. 122, fig. *14*) or more or less rough with serrations on all sides (Pl. 125, figs. *4*, *5*); they are commonly longitudinally striated, the striations being raised as more or less evident ridges, which may be quite serrate; there is sometimes a marked difference between base and tip of spine in the smoothness or roughness of its surface.

[1] The numeration of the plates is continuous throughout the reports on the Hawaiian and other Pacific Echini (Memoirs M. C. Z., **34**).

None of these varying peculiarities of the primary spines are distinctive of particular groups but examination of the miliary spines shows two distinct types of structure, one of which occurs only in two families, the other only in the remaining three. In the Fibulariidae and Laganidae, the miliary spines have the appearance of groups of flattened rods, more or less expanded at their tips, and bound together by horizontal bars placed rather near together. At the base, these spines seem fairly solid but distally they have an open, lattice-like appearance. Attention was first called to the characteristic structure of these small spines by de Meijere (1904, *loc. cit.*), who showed how the flattened rods differed in different species. They are sometimes gradually (Pl. 124, fig. *14*), sometimes abruptly (Pl. 124, fig. *18*) expanded at the tip, and the terminal margin may be smooth or finely or coarsely serrate. The spine as a whole is commonly somewhat expanded at tip, *i. e.* the rods are more or less flaring. Often the rods are not all of equal length but those of one side may be much shorter than the others; in such a case the tip of the spine is more or less oblique. Examination of much material has convinced me that the degree of obliqueness is subject to great variation due to the position of the spine on the test and the amount of wear it has received. The amount of serration on the rod-tips is also affected by the same factors, and smooth, finely serrate, and coarsely serrate rods occur in the same individual.

In the remaining families of Clypeastrina, the miliary spines are solid like the primaries but the longitudinal ridges are dentate and their chisel-like teeth are more or less finely serrate (Pl. 122, figs. *7*, *8*, *10*). Such miliary spines may be cylindrical (Pl. 122, fig. *7*) or more or less swollen at the tip (figs. *8*, *10*). They do not show signs of wear as evidently as do the miliaries of the Laganidae. They show little diversity in form or structure and are of little use for systematic purposes.

One of the most interesting facts brought out by a study of the pedicellariae of the clypeastroids is that these organs reveal a steadily decreasing importance as we pass from the older and more primitive forms to those which are more highly specialized. In most species of Clypeaster pedicellariae of at least three kinds are more or less common, and may even be abundant. No globiferous pedicellariae are known in the genus, or in any of the Clypeastrina, but tridentate, ophicephalous, and triphyllous forms occur on both oral and aboral surfaces. As a rule, the ophicephalous pedicellariae are chiefly aboral and the tridentate chiefly oral, while the triphyllous may occur on either surface with equal frequency. In some species, large pedicellariae, like the tridentate, occur

with four valves and these *quadridentate* pedicellariae might perhaps be considered the most specialized form occurring in the suborder. In the Laganidae also, pedicellariae of three kinds occur and in some species are quite common and the same seems to be true of the Fibulariidae, so far as known. In Arachnoides, pedicellariae are excessively rare, some fine specimens seeming to lack them altogether. Those that do occur are all of one kind, small and with only two valves. In the Scutellidae, we find a similar marked reduction in the number and size of the pedicellariae. Only in one species of Echinodiscus have I found ophicephalous pedicellariae, and in no other genus of the family. The tridentate and triphyllous pedicellariae are very small, and commonly have but *two* valves. The triphyllous are so small, it is only by the greatest care that they can be found. The tridentate, or more properly the bidentate, in *Echinarachnius parma* show the further degradational feature of a total lack of apophyses in the valves. Taking all the facts into consideration it seems clear that the clypeastroids have sprung from a stock, provided with ophicephalous, tridentate, and triphyllous pedicellariae and it may be added that to no family of regular Echini do they show a closer resemblance in these particulars than to the Saleniidae. Adaptation to a more or less subarenaceous life seems to have been the cause of a degradational change in the pedicellariae so that as the test has become more and more flat and discoidal, there has been first a loss of the ophicephalous pedicellariae, and a reduction in number of all kinds, and this has been followed by a reduction in the size and number of valves of the pedicellariae themselves, until the condition is reached which is characteristic of Arachnoides, where the pedicellariae are very scarce, all of one kind, very small and with only two valves. Further reduction to complete extermination seems to occur in some individuals of this genus.

The *ophicephalous* pedicellariae of clypeastroids, when present at all, always have three valves (Pl. 123, fig. *17*), of which one has a very large basal "loop," the second has a moderate one and the third has little or none (Pl. 123, figs. *5*, *6;* Pl. 124, figs. *10–12*). The shape of the loop shows great diversity but is of little importance as a specific character. The blade (Pl. 123, fig. *4;* Pl. 124, figs. *9*, *21*) is equally variable in form but is of more taxonomic importance. The stalk of these pedicellariae is longer than the head but is solid and rather stout, and is hollowed at the top (Pl. 124, fig. *13*) so that the loops actually set into the cavity. The heads are always small, .10–.20 mm. long with the loops adding about half as much again.

The *bidentate, tridentate,* and *quadridentate* pedicellariae are the commonest

forms, occurring in all the genera examined, although they are often very "few and far between." In them all, the stalk usually about equals the head, though it may be either longer or shorter, and the neck is relatively quite short. They differ from each other chiefly, as the names used indicate, in the number of valves. The *quadridentate* (Pl. 123, figs. *10*, *11*) are the least common, having been found only in certain species of Clypeaster. They are the largest pedicellariae of the suborder, the valves sometimes exceeding a millimeter in length. The valves are compressed and meet only at the tip. The *tridentate* (Pl. 123, figs. *1*, *29*, Pl. 124, fig. *1*) are also often of large size, with valves exceeding a millimeter in length, but they may be very small, not one tenth the size of the large ones. They are found in all species of Clypeaster, and in the Laganidae, Fibulariidae, and some Scutellidae. The valves meet at or near the tip or for more or less of their entire length; they are sometimes straight but more commonly are curved to a greater or less degree. These pedicellariae show great diversity not only in size and relative abundance, but in the form of the valves. The latter occasionally have "loops" as in ophicephalous pedicellariae, but the shape of the blade never approaches the characteristic ophicephalous form. With the triphyllous pedicellariae however, the tridentate show an evident intergradation and the line between the two kinds is purely arbitrary. The *bidentate* pedicellariae (Pl. 125, figs. *2*, *23*) occur only in the Arachnoididae and Scutellidae. They do not occur with either quadridentate or tridentate. They are always small, the valves never exceeding .50 mm. and being usually less than .30. The two valves meet only at or near the tips and are usually distinctly compressed. They are of very diverse shapes and those of Echinarachnius are remarkable for the absence of any apophysis, so that no distinction between base and blade is feasible.

The *biphyllous* and *triphyllous* pedicellariae differ from the bidentate and tridentate chiefly in being smaller and in having the valves of more bizarre shape and in usually having a very much longer stalk and longer neck. They differ from each other only in the number of valves. The *biphyllous* (Pl. 125, fig. *7*) have the valves usually somewhat compressed but meeting broadly at the tip; they are only .05–.10 mm. in length. They are found only in the more specialized Scutellidae. The *triphyllous*, on the other hand, occur in the less specialized Scutellidae and in all the other families except the Arachnoididae. The valves are no larger than those of the biphyllous and because of their very small size they are often exceedingly hard to find. The blade is generally somewhat expanded and its margin may be finely serrate (Pl. 123; figs. *24*, *25*) or dentate (Pl. 124, figs. *20*, *23*).

Although *sphaeridia* occur in all known genera of Clypeastrina, their small size and more or less complete concealment within the calcareous matter of the test itself makes them of little use for systematic purposes. It may be mentioned in passing that the presence of depressions or even deep cavities within which the sphaeridia occur is characteristic of the Arbaciidae alone among the families of regular Echini.

The *calcareous particles* in the tube-feet of the clypeastroids show the same gradual decrease in size and importance that the pedicellariae reveal. This is very probably associated with the change of function of the pedicels from locomotor to respiratory. In the less specialized genera, there is a well-developed calcareous plate in the disk of each pedicel; this plate is perforated by a large central opening and many small ones nearer the margin; it is more or less well provided with projections on the outer margin. Besides this plate a few calcareous rods may be present in the wall of the foot but they are insignificant and commonly wanting. In the Laganidae the terminal plate is less well developed than in Clypeaster and in most cases seems to be wanting as it is also in the Fibulariidae. In the Arachnoididae, it is reduced to a very slender ring surrounding the tip of the pedicel. In the Scutellidae, it is entirely wanting but in several genera is replaced by two rods, lying side by side at the center of the disk; these rods are somewhat bent or curved, so that they are further apart at the middle than at either end, and on the outer side is a projecting tooth or several knobs.

The Families of Clypeastrina.

In the Revision of the Echini, Mr. Agassiz (1873, Rev. Ech., pt. 3, p. 505, 524) recognizes two families of clypeastroids, the Euclypeastridae and the Scutellidae. In the former, he grouped the genera into three subfamilies, Fibularina, Echinanthidae, and Laganidae; Arachnoides he placed in the Scutellidae, expressing himself (p. 529) as strongly opposed to the removal of the genus from that family. Duncan (1889, Journ. Linn. Soc. Zool., **23**, p. 143) adopts essentially the same classification but he raises each of the three subfamilies to full family rank, calls the Echinanthinae by the more correct name Clypeastridae and recognizes the peculiarities of Arachnoides by making it the only genus of a subfamily "Arachninae" under Scutellidae. He omits any subfamily name for the other genera of the family, but no doubt he intended to use "Scutellinae." Gregory (1900, Lankester's Treatise on Zoology, **3**, p. 316) adopts the same four families but removes Arachnoides from the Scutellidae altogether and makes it a separate

subfamily of the Clypeastridae. MacBride (1906, Echinodermata, Cambridge Natural History, 1, p. 549) adopts the same four families but, without any explanation of such an inexcusable move, puts Arachnoides in the Laganidae! Evidently then, except for the genus Arachnoides, all writers are agreed on the primary subdivisions of the clypeastroids. As I consider the arrangement of the auricles of fundamental importance, I believe Gregory's classification is the most natural of those hitherto proposed, but, as I have already pointed out (1911, Ann. Mag. Nat. Hist., ser. 8, 7, p. 593–605), Arachnoides is so different from all Clypeastridae, I prefer to raise Gregory's subfamily Arachnoidinae to full family rank, and thus recognize five families of Clypeastrina.

There can be little question that the Clypeasteridae are the least specialized forms, the character of the auricles, the structure of the spines, and the pedicellariae all giving weight to this conclusion. From such a stock or a nearly related one, Arachnoides has developed, becoming very flat and discoidal, and losing its pedicellariae in connection with its subarenaceous life. The Laganidae and Fibulariidae show by their miliary spines and pedicellariae, as well as by the structure of the auricles and interambulacra, that they have come from a common stock, for I cannot believe that the simple features of the fibularine ambulacra are primitive. They seem to show a secondary simplicity. The Scutellidae are of course the most specialized forms, but which genus is to be considered the most extreme I am not prepared to say. Very likely it is Rotula but my material of that genus does not warrant an opinion.

Key to the Families of Clypeastrina.

Auricles separate, each placed more or less clearly on the ambulacrum.
- Test rarely discoidal, and usually not flat; anus marginal or inframarginal; genital pores 5. CLYPEASTRIDAE.
- Test very flat, discoidal; anus supramarginal; genital pores 4 . . . . . ARACHNOIDIDAE.

Auricles fused into a single piece situated on the interambulacrum.
- Test seldom discoidal and never with marginal slits or lunules; aboral end of each interambulacrum consists of a single large plate adjoining genital; ambulacral furrows on oral surface short and indistinct, or wanting.
  - Petals more or less perfect; madreporic pores numerous; size moderate to large (15–150 mm. in length) . . . . . LAGANIDAE.
  - Petals reduced and often rudimentary; only one madreporic pore; size small, rarely up to 15 mm. in length . . . . . FIBULARIIDAE.
- Test flat and usually discoidal, often with marginal slits or lunules; aboral end of each interambulacrum with the usual pair of small plates adjoining genital; ambulacral furrows distinct, at least the posterior reaching to the margin . . SCUTELLIDAE.

CLYPEASTRIDAE Agassiz.

This family includes the largest clypeastroids known and very few of the species are less than 75 mm. in length when fully grown. Although the arrangement of the auricles and the lantern-muscles (see Jackson, 1912, Mem. Boston Soc. Nat. Hist., 7, p. 196), the structure of the spines, and the number, variety and form of the pedicellariae all indicate that the family as a whole is the least specialized in the suborder, yet many of the species show by the completely formed petals, the very flat test, and the position of the anus a very considerable specialization. While the test is decidedly flattened in most of the species, there are some in which it is more or less highly arched and the generic position of these has been a source of considerable discussion. Among these, an Australian species, described in 1878 by Tenison-Woods under the name *Echinanthus tumidus*, is particularly interesting and there is no doubt Bell was quite right in making it the type of a new genus, Anomolanthus. Another of the high forms and one of the best known members of the family has long borne the name of *Echinanthus rosaceus* but under the International Code, the name Echinanthus may not be used for a clypeastroid (see H. L. Clark, 1911, Ann. Mag. Nat. Hist., ser. 8, 7, p. 594). Moreover *rosaceus* is undoubtedly the type of Lamarck's genus Clypeaster and consequently, if the highly arched and the flattened species of Clypeastridae are to be separated generically from each other, it is the former and not the latter which retain the name Clypeaster. But after a careful study of nearly all the recent species, I have concluded that the gradations in the form and structure of the test are so complete, it is better to let all the species of the family, recent, Quarternary, and Tertiary, except the Australian form referred to above as Anomolanthus, rest in the single genus Clypeaster. There is thus no occasion to use Duncan's proposed genera Plesianthus and Diplothecanthus. Possibly a careful revision of the fossil forms may show some good generic groups among them but for the recent species, a single genus will answer.

Key to the Genera of Clypeastridae.[1]

Poriferous areas of petals divergent, not incurved distally; anus marginal . . . . . *Anomolanthus.*
Poriferous areas of petals more or less incurved distally; anus inframarginal . . . . *Clypeaster.*

[1] In this and all subsequent keys only recent forms are considered.

Anomolanthus.

Bell, 1884. Proc. Zool. Soc. London, p. 43.
Type, *Echinanthus tumidus* Tenison-Woods, 1878. Proc. Linn. Soc. N. S. W., **2**, p. 169.

It is difficult to determine whether one or two specimens of this highly interesting clypeastroid have been taken, for Bell's introductory paragraph is ambiguous on this point. Apparently, however, the specimen he studied was the holotype, now in the Australian Museum, Sydney, which is 140 mm. long, 115 mm. wide and 63 mm. high. No other specimen has been recorded since Bell's paper was published, but it is greatly to be hoped that further material will be secured for no clypeastroid gives so great promise of throwing light on the phylogeny of the group. It is unfortunate that the locality where the type was obtained is not known and that even its being from Australian waters is not past doubt.

Clypeaster.

Lamarck, 1801. Syst. Anim. sans Vert., p. 349.
Type, *Echinus rosaceus* Linné, 1758. Syst. Nat., ed. 10, p. 665.

It is not necessary to repeat here the discussion of the nomenclatural questions involved in making *rosaceus* the type of this genus; the details may be found in my paper already referred to (1911, Ann. Mag. Nat. Hist., ser. 8, 7). It may be well, however, to call attention to the fact that the ultimate settlement of the matter will depend not merely on whether pre-Linnean names are to be accepted but also on the interpretation of Linné's, Leske's, and Lamarck's references to the species involved. The number of recent species of Clypeaster is much larger than has hitherto been supposed. More than thirty-five species have been described, but as all but seven or eight of these were described before the Revision was published, and as Mr. Agassiz only recognized half a dozen species in that work, there has been an impression that there were not more than a dozen or fifteen valid species. Indeed in Bronn's Thier-reichs (1904) only eight species (grouped in three genera!) are admitted. My study of the large series of specimens in the M. C. Z. collection and the very interesting material gathered by the Albatross has convinced me that we should recognize at least nineteen species, of which three have not hitherto been described and one other requires a new name.

I have the pleasure of expressing here my most sincere thanks to Dr. Ludwig

Döderlein of Strassburg for the loan of specimens representing his Japanese species and for his kindness in answering questions and expressing opinions on the validity of certain forms. Through his kindness, I have been able to accept his opinion that the genus Alexandria of Pfeffer is a synonym of Clypeaster, being based apparently upon a specimen of the species here called *humilis*. And we are further agreed that *C. clypeus* and *C. excelsior* of Döderlein are synonyms of his *C. japonicus*. The clypeastroid described by Yoshiwara as *C. ogasawaraensis* is also *C. japonicus*. Dr. Seitaro Goto of the Imperial University, Tokyo, was so good as to have the type specimen sent to me and I am thus able to reach a positive conclusion. For his courtesy, I take pleasure in thanking Dr. Goto.

Owing to Loven's attempt (1887, Bih. K. Svenska Vet.-Akad. Handl., **13**, afd. 4, no. 5, p. 171–176) to apply Linné's names *rosaceus* and *reticulatus* to species, with which they had never been associated, most unfortunate confusion has crept into the nomenclature of the genus. For this reason it has seemed to me important to give a certain amount of synonymy under the species which have long been known, especially since Loven's combinations and determinations have been incorporated into so widely used a text-book as Bronn's Thier-reichs.

Specific distinctions in the genus are based upon the form of the test, particularly with reference to the thickness of the margin and the ratio of length to breadth, upon the position of the anus, upon the form, relative length and openness of the petals, and upon the tuberculation of test, particularly as shown in the anterior ambulacrum, between the pore-pairs. These features are, of course, more or less variable, especially the form of the test, yet even in the most variable species there seem to be fairly well-defined limits. Few of the species are hard to recognize and it is probable that the number of valid species is larger rather than smaller than that listed here.

While the spines and pedicellariae are only of secondary importance in distinguishing the species of Clypeaster, so little has hitherto been published about them, that a few notes may be inserted here. The primary spines are usually smooth (Pl. 122, figs. *4*, *9*, *11*) but in *europacificus*, *rotundus* (Pl. 122, figs. *5*, *6*), *subdepressus*, and *prostratus*, they are more or less rough or serrulate near the tip; in some other species serrations are often found near the tip of the larger primaries (Pl. 122, figs. *14*, *15*). In *lamprus* (Pl. 122, figs. *1–3*), many oral primary spines are conspicuously elongated and broadly flattened at the tip, unlike any spines found in other species. In some species, notably *pallidus* (Pl. 122, fig.

16–18) the primary spines are spatulate or swollen at the tip, at least abactinally. In *ravenelii*, the primaries around the mouth (Pl. 122, figs. *12*, *13*) are noticeably modified. So far as the miliary spines are concerned, in *audouini*, *japonicus*, *leptostracon*, *rarispinus*, and *virescens*, they are more or less swollen or club-shaped at tip (Pl. 122, figs. *8*, *10*), while in all the other species they are cylindrical or terete (Pl. 122, fig. *7*), though in *lamprus*, and in individual cases in other species, some of them may approach the club-shaped form.

The *quadridentate* pedicellariae (Pl. 123, figs. *10*, *11*) have so far been found only in *ravenelii* and *subdepressus*, but they will probably be detected in some other species. Their valves (Pl. 123, fig. *7*) are narrow, compressed and meet only near the tip. The *tridentate* have been found in all of the nineteen species but they show considerable variety in form and in a few species (*audouini*, *australasiae*, *humilis*, *rotundus*) they seem to be very scarce. The valves may be broadly in contact (Pl. 123, figs. *20*, *21*, *29*) or meet only at the tip (Pl. 123, fig. *1;* Pl. 124, fig. *1*); they may be long and narrow throughout (Pl. 123, figs. *15*, *16*) or expanded at the tip (Pl. 123, figs. *2*, *3*, *12*, *19;* Pl. 124, figs. *2–6*), or broad and somewhat leaf shaped (Pl. 123, figs. *26*, *27*). In *lamprus*, the blade is almost tubular and only a little expanded at the tip (Pl. 123, fig. *22*). The *ophicephalous* pedicellariae (Pl. 123, fig. *17*) are less common than the tridentate in most species and were not found at all in *audouini*, *prostratus*, and *rotundus;* they were very scarce in *australasiae* and *humilis*. The opening of the blade (Pl. 123, figs. *4*, *28*) is broad and low and surrounded by conspicuous teeth. The loops vary much in size and form in the three valves of the same pedicellaria (compare Pl. 123, figs. *5* and *6* or figs. *13* and *14*). In many cases, the largest valve has a notable bihamate loop (Pl. 123, figs. *8*, *9*, *30*, *31*), and these hooks may even unite at the ends with the sides of the loop (Pl. 123, fig. *23*). The *triphyllous* pedicellariae (Pl. 123, fig. *18*) are so small they are difficult to find, and while they probably occur in all the species, I failed to find them in several. The valves (Pl. 123, figs. *24*, *25*) are broad and flat with finely serrate margins.

Key to the Species of Clypeaster.

Margin of test very thick, the upper surface rising so uniformly from ambitus to madreporite that a real margin can hardly be measured, but even in flattened individuals it is rarely less than .30 test-length; height of test rarely less than .35 test-length; lower surface of test deeply concave.

Test not evenly convex above, the median area of petals being more or less markedly elevated, not only above the poriferous areas but above the interambulacra also; pore-pairs in petals numerous (more than forty-five on each side in an unpaired

petal 22 mm. long); primary spines slightly and uniformly tapering to a blunt point; color more or less dark, reddish brown . . . . . *rosaceus.*

Test very evenly convex above, the petals scarcely at all elevated; pore-pairs much less numerous (thirty-nine on each side, in an unpaired petal 37 mm. long); primary spines acute, often enlarged just below tip; color light reddish . . . . *pallidus.*

Margin of test more or less distinct, its thickness usually less than .20 and often less than .10 test-length; height of test seldom exceeds .30 test-length.

Test about as wide as long, usually distinctly pentagonal with more or less concave sides, but sometimes the ambitus is circular; between ambitus and distal end of petals, the test is flat and its height there is only .03–.08 test-length; lower surface of test not at all concave.

Petals, especially unpaired one, broadly open at distal end.

Petals rather broad, the unpaired one being more than half as wide as long, the others somewhat narrower; poriferous areas parallel or somewhat diverging; tuberculation of test rather coarse (sixty–sixty primary tubercles to each sq. cm. of surface, aborally, near margin); margin somewhat swollen, its thickness about .08 test-length . . . . . *ravenelii.*

Petals narrower, width of unpaired one .40–.50 its length; poriferous areas converging distally; tuberculation of test less coarse; margin thin, not at all swollen, its thickness about .03–.04 test-length . . . . . *europacificus.*

Petals narrow, more or less closed at distal end.

Test moderately high (v.d. = .15–.20 test-length) with somewhat swollen margin (thickness = about .08 test-length); petaloid area rather more than .60 test-length . . . . . *audouini.*

Test very flat (v.d. hardly .15 test-length); margins not swollen, their thickness about .04 test-length; petaloid area .45–.55 test-length . . . *rarispinus.*

Test distinctly longer than wide, ambitus usually rounded but often pentagonal with nearly straight sides.

Test rather high (v.d. = .20–.35 test-length) with thick margins (thickness = .09–.22 test-length); aboral surface inclining upward more or less uniformly from margin (not in *reticulatus*); lower surface concave or (in *speciosus* and usually in *japonicus*) distinctly sunken only near mouth; tuberculation rather coarse (finer in *australasiae*) the ridges between pore-pairs of unpaired petal with only 4–6 (more in *australasiae*) or fewer primary tubercles.

Lateral petals more or less widely open.

Tuberculation rather coarse; pore-pairs in unpaired petal numerous (more than forty-five in a petal 33 mm. long), the ridges between narrow, each with a single series of four to six primary tubercles.

Test high (about .25 test-length), markedly concave beneath; color light yellowish brown . . . . . *ochrus.*

Test more flattened (about .20 test-length), slightly concave beneath; color deep purplish brown or blackish purple . . *speciosus.*

Tuberculation finer; pore-pairs not numerous (only about 45 on each side in a petal 56 mm. long); ridges between broad with 6–12 primary tubercles, often in double series . . . . . *australasiae.*

Lateral petals (at least anterior pair) more or less completely closed.

Size large, length up to 100 mm. and more; width exceeding .80

length; anterior petals more than .80 as long as unpaired one; lower surface not usually markedly concave, though mouth is distinctly sunken . . . . . *japonicus.*

Size small, not exceeding 75 mm. in length; width usually not .80 length; anterior petals short, scarcely .75 as long as unpaired one; lower surface strongly concave.

Unpaired petal widely open, with numerous pore-pairs (36 on each side in petal 10 mm. long); petaloid area not at all depressed . . . . . *lytopetalus.*

Unpaired petal nearly closed, with fewer pore-pairs (28 on each side in petal 14 mm. long); petaloid area in adult more or less depressed, at least the distal portion lying lower than the thickened test-margin though the apical system may be much higher *reticulatus.*

Test rather low (v. d. = .15–.22 test-length), with thin margins (.04–.08 test-length); aboral surface more or less flat distal to petals; lower surface flat or slightly and gradually concave.

Primary tubercles numerous, small; on each ridge between pore-pairs of unpaired petal, there is a single regular series of 6–15; unpaired petal with poriferous areas converging distally though petal may remain open.

Unpaired petal with relatively few pore-pairs (about 50 on each side in a petal 40 mm. long); median area of petals markedly obovate, narrow proximally and broadest distally; poriferous areas converging rather abruptly, and tending to close the petals, especially the anterior and posterior pairs . . . . . *humilis.*

Unpaired petal with more numerous pore-pairs (60–70 on a side in a petal 40 mm. long); median area of petals not obovate, usually as wide at the middle as anywhere; petals more or less open.

Test about .90 as wide as long or wider; anterior lateral petals about .90 as long as unpaired petal.

Unpaired petal broad and widely open; its breadth is decidedly more than half its length and it is at least twice as widely open as posterior pair . . . . . *prostratus.*

Unpaired petal narrower with poriferous areas more convergent; its breadth seldom exceeds half its length and is usually less; it is sometimes widely open but not more so than posterior pair . . . . . *rotundus.*

Test about .80 as wide as long; anterior lateral petals short, only about .80 as long as unpaired one . . . . . *subdepressus.*

Primary tubercles scattered, rather large especially on interambulacral areas orally; on each ridge between pore-pairs of unpaired petal, there are not more than four and often there is only one or none; unpaired petal short, only .25–.30 test-length, with poriferous areas parallel or somewhat diverging (in small specimens somewhat convergent).

Primary tubercles and their spines orally not strikingly peculiar; petals (at least in adults) much wider than half their length.

Test .90–.95 as wide as long, not depressed at distal end of petals; color, yellowish brown becoming deep green after

death and then gradually changing to brown, dull greenish, greenish yellow or pale buff . . . . . *virescens.*

Test about .80–.85 as wide as long, somewhat depressed distal to petals; color, yellow of several shades, with dusky markings, hardly changing at all after death . . . . . *leptostracon.*

Primary tubercles of interambulacra orally, very large and deeply sunken, bearing long spines which are conspicuously flattened and expanded at tip; petals in adults half as wide as long or less . . *lamprus.*

Clypeaster rosaceus.

Echinus rosaceus Linné, 1758. Syst. Nat., ed. 10, p. 665.
Clypeaster rosaceus Lamarck, 1801. Syst. Anim. sans Vert., p. 349.
Echinanthus rosaceus Gray, 1825. Ann. Phil., **26**, p. 427. A. Agassiz, 1872. Rev. Ech., pt. 1, p. 106.
Clypeaster reticulatus Lovén, 1887. Bih. K. Svenska Vet.-Akad. Handl., **13**, afd. 4, no. 5, p. 175.
Diplothecanthus reticulatus Duncan, 1889. Journ. Linn. Soc. Zool., **23**, p. 153. (Bronn's Thierreichs, 1904, **2**, abt. 3, buch 4, p. 1382).

Plate 123, fig. *1.*

This is a characteristic species of the West Indian region, ranging as far northward as Charleston, S. C.

Clypeaster pallidus, sp. nov.

Plates 122, figs. *16–18;* 123, figs. *2–4;* 139, figs. *1–3.*

Length 108 mm.; breadth, 85 mm.; height, 42 mm.; mouth sunken 22 mm. below sides of test. Test rather evenly convex, sloping uniformly from ambitus to apex; median areas of petals little elevated above pore-pairs and hardly at all higher than interambulacra. Tuberculation of test quite uniform; primary tubercles with sunken areolae, from 100 to 150 per sq. cm. of test surface aborally; ridges between pore-pairs of unpaired petal with a single series of 6–7 primaries; miliary tubercles six or seven times as numerous as primaries, low and granular. Madreporite stellate, 5 mm. across, the ocular plates and pores fairly distinct in the re-entrant angles. Genital pores moderately large, 1–2 mm. distant from the madreporite, in the interradii. Unpaired petal with 39 pore-pairs on each side, 37 mm. long, 19 mm. wide at middle, and 20 mm. wide, half way between middle and tip; the median area is 9 mm. and 10 mm. at the same two points respectively; hence the poriferous areas are about 5 mm. across where widest; the petal is open by fully 3 mm. Anterior petals somewhat

shorter and wider, about 36 by 21 mm. and about equally open at tip. Posterior petals longer and wider, 41 by 22 mm., about equally open. Periproct close to margin, about 5 mm. across, covered with numerous small, miliary bearing plates.

Primary spines of aboral surface, 2 or 3 mm. long, smooth, pointed, slightly flattened and often distinctly larger below the tip, thus becoming somewhat spatulate (Pl. 122, figs. *17*, *18*); on oral surface, the primaries are thicker, blunter, and longer, especially around the mouth (Pl. 122, fig. *16*). Miliary spines long, slender, and cylindrical or terete. Tridentate pedicellariae very common and large (heads = 1–1.6 mm.) on oral surface but rare and small (heads = .25–.75 mm.) aborally; the valves vary much in shape with their size. The small pedicellariae have broad, nearly straight valves, coarsely serrate on margin and meeting for nearly the full length of the blade; in larger ones, the valves are narrow and compressed, finely serrate along distal half of blade, where they meet; in the largest, the valves (Pl. 123, figs. *2*, *3*) are curved, dentate on margin, compressed and decidedly expanded at tip, where they meet. Ophicephalous pedicellariae common aborally, wanting on oral side; heads about .5 mm. long; opening of blade (Pl. 123, fig. *4*) broad and low, guarded by conspicuous teeth. Triphyllous pedicellariae rare, or at any rate, very hard to find; valves broad and flattened, about .07 mm. long, similar to those of *rotundus* (Pl. 123, fig. *25*).

Color aborally, light reddish; test yellowish brown when cleaned of the overlying red-brown skin; spines white or whitish, but with enough reddish tinge to give, with the skin, a general light reddish color; orally the skin is dull greenish yellow, while the spines are pale brown, with a reddish tinge. These are the colors of the holotype, dried after thirty years in alcohol; the color in life is not known.

A second, smaller specimen is very similar but the colors are paler, the test aborally is reddish and the primary tubercles are less numerous (4–6) on the ridges between the pore-pairs of the unpaired petal.

The holotype is from Blake St. 276, off Barbados, 94 fms.; the smaller specimen is from Blake St. 177, off Dominica, 118 fms.

These specimens were labelled "*E. rosaceus*," without critical examination, and were never subsequently examined until after Mr. Agassiz's death. When compared with specimens of *rosaceus* of the same size, the differences are so evident and seem to be so constant, I have not hesitated in considering this an undescribed species.

Clypeaster ravenelii.

Stolonoclypus ravenelii A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 265.
Clypeaster ravenellii A. Agassiz, 1883. Mem. M. C. Z., **10**, p. 43.

Plates 122, figs. *12–14;* 123, figs. *5–10.*

In his account of the Blake Echini, Mr. Agassiz gives very satisfactory figures of this species; I have given here some additional figures to show the spines and pedicellariae. By an unfortunate misprint on p. 42 of his Blake report, Mr. Agassiz says that Pl. XI^{c} of the Revision represents this species; that plate illustrates details of structure in the test of *C. rosaceus.* Apparently Mr. Agassiz intends to refer to Pl. XI^{e} where there are two figures of a Clypeaster, labelled "*subdepressus,*" which resemble *ravenelii* to a certain extent, but which really represent *C. prostatus* Ravenel, a species Mr. Agassiz considered synonymous with *subdepressus.* The type of *ravenelii,* a young specimen, was taken among the Florida Keys; the Blake took specimens on the Yucatan Bank, Gulf of Mexico; near the Danish West Indies; and off Montserrat, Grenada and St. Vincent. The depths were 34–124 fms. The largest specimen is 132 mm. long, 136 mm. wide and 36 mm. high.; the concavity of the posterior side is 4 mm. The original type specimen is only 40 × 40 × 7 mm.

Clypeaster europacificus,[1] sp. nov.

Plates 123, figs. *13–16;* 129; 130; 131; 136, fig. *1.*

Length from distal margin of unpaired ambulacrum to distal margin of posterior interambulacrum, 165 mm.; greatest breadth, just posterior to antero-lateral ambulacra, 165 mm.; height, mouth to apex, 40 mm. Form pentagonal, with sides deeply concave; posterior side has the concavity 12 mm. deep; margins rather thin, about 7 mm. or not quite .06 test-length. Test highly arched in middle but rather flat distal to petals. Tuberculation of test rather coarse or better rather sparse; primary tubercles very small, with sunken areolae, about eighty per sq. cm. of test surface aborally; ridges between pore-pairs of unpaired petal, with a single series of seven or eight primaries; miliary tubercles fairly numerous, about ten times as many as primaries but not closely crowded. Madreporite pentagonal (in other specimens circular) with ocular plates and

[1] *Eurous* = eastern + pacificus, in allusion to its geographical distribution.

pores evident. Genital pores large, close to madreporite in interradii. Unpaired petal with about 56 pore-pairs on each side, 61 mm. long, 20 mm. wide at middle and only 21 mm. half way between middle and tip; median area 10 mm. wide with almost parallel sides; hence poriferous area rather more than five millimeters wide where widest; petal open by nearly 10 mm. Anterior petals 54 mm. long and 20 mm. wide, open by 5 or 6 mm. Posterior petals almost exactly identical with anterior. Periproct submarginal, small, scarcely 4 mm. across.

Primary spines rough at tip; those of aboral surface quite small, seldom exceeding 2 mm. in length; those of oral surface larger, near mouth about 4 mm. long or if short, much stouter than those of aboral surface. Miliary spines cylindrical or terete, quite numerous. Only ophicephalous and tridentate pedicellariae were found. The former have heads about .30 mm. long and stalks nearly twice as much; the valves (Pl. 123, figs. *13*, *14*) have the blades quite spinous at base, with the opening low and broad and the margin finely serrulate. The tridentate pedicellariae have the stalk about equal to the head; the valves are .15–.75 mm. long, narrow, straight, compressed and meeting for nearly half their length.

Color of holotype and other large specimens dull olive-green, brighter orally; smaller specimens are more red-brown or red-purple and very small specimens are quite distinctly reddish purple. In all the larger specimens, the ambulacra on the oral surface are darker than the interambulacra but the boundaries between the different areas are sharply zigzag lines, making rather of a handsome color-pattern, the distinctness of which varies greatly in the different specimens. The color in life is not known.

The holotype is from Albatross St. 2795, in the Gulf of Panama, 33 fms.

There is a very good series of this interesting and well-characterized clypeastroid, taken by the Albatross at various points in the eastern tropical Pacific. The smallest specimen is nearly circular in outline and only 6 mm. in diameter; of course its identification is not certain but I see no reason for questioning it. Others are 17, 26, 32, and 37 mm. in length, with the width practically the same; in these specimens the form is more pentagonal. The largest specimen is 196 mm. across but the length in the antero-posterior axis is only 191 mm.; the concavity of the posterior side is however 12 mm. The color of this specimen is, like that of the type, very distinctly olive-green, but there is good reason for believing that this is due to the copper can in which they were stored for many years; their labels are very green. The other specimens are all more or

less reddish purple, which is probably nearly the color in life. While this species resembles *ravenelii* in form, it is not so heavy and the test-margin is very much thinner. Moreover the petals are very different, so that the two species cannot be confused.

The ALBATROSS took *europacificus* at the following places:—

Station 2795. Gulf of Panama, 7° 57′ N., 78° 55′ W. Bott. temp. 64.1°. 33 fms. Gy. s., bk. sp., brk. sh.

Station 2813. Northwest of Hood Island, Galapagos, 1° 21′ S., 89° 40′ 15″ W. Bott. temp.? 40 fms. Co. s.

Station 2829. Off Cape St. Lucas, L. Cal., 22° 52′ N., 109° 55′ W. Bott. temp. 74.1°. 31 fms. Rky.

Station 2995. Off Clarion Island, 18° 19′ N., 116° 44′ 15″ W. Bott. temp. 68.4°. 31 fms. Gy. s., brk. co.

Station 3014. Gulf of California, 28° 28′ N., 112° 04′ 30″ W. Bott. temp. 62.9° 29 fms. Gy. s.

Station 3390. Off Cape Mala, Panama, 7° 26′ 10″ N., 79° 53′ 50″ W. Bott. temp. 62.6°. 56 fms. Fne. gy. s., gr.

Bathymetrical range, 29–56 fms. Extremes of temperature, 74.1°–62.6°. Fifteen specimens.

Clypeaster audouini.

Fourtau, 1904. Bull. Inst. Egypt, ser. 4, **4**, p. 418.

Plates 122, fig. *10;* 123, fig. *24.*

As Fourtau gives no details concerning spines and pedicellariae; it may be mentioned here that the primary spines are smooth and the miliaries have conspicuously club-shaped tips (Pl. 122, fig. *10*). Pedicellariae are exceedingly scarce in the three specimens at hand. The single tridentate found had valves .36 mm. long, shaped somewhat like those of *rotundus* (Pl. 123, fig. *27*) but with the blade a trifle more angular on each side and not so evenly rounded. The triphyllous had valves .09 mm. long and quite broad and flat (Pl. 123, fig. *24*). This species is very well characterized. It appears to be distributed along the whole East African coast for while Fourtau's specimens were from the Red Sea, those of the M. C. Z. collection are from Natal.

Clypeaster rarispinus.

De Meijere, 1903. Tijdsch. Nederland. Dierk. Ver., ser. 2, 8, p. 7.

The only addition I have to make to de Meijere's account is the presence of ophicephalous pedicellariae, which he did not find. They are small (heads only .15–.20 mm. long) and not at all common. The triphyllous pedicellariae have valves only .07 mm. long, but the stalk is seven times as long as the head. In the tridentate the valves are curved, .43 mm. long and have the blade gradually widened near tip. They are thus somewhat like those of *audouini*, and the miliary spines are much like those of that species. The Siboga took *rarispinus* at four stations in the Dutch East Indies and it is not yet known from elsewhere.

Clypeaster ochrus,[1] sp. nov.

Plate 141, figs. *1–3*.

Length, 94 mm.; breadth, 83 mm.; height, 24 mm.; mouth sunken 12 mm. below sides of test. Test moderately high and rather evenly arched, deeply concave beneath; margins 8–9 mm. thick or rather more than .08 of test length. Tuberculation of test, rather coarse; primary tubercles small, with sunken areolae, about 100 per sq. cm. of test surface, aborally; ridges between pore-pairs of unpaired petal with a single series of four to six primaries; miliary tubercles very numerous, probably twenty times as many as primaries, covering the test quite uniformly. Madreporite pentagonal, 4 mm. across; ocular plates and pores not very distinct. Genital pores large, close to interradial angles of madreporite. Unpaired petal with about fifty-three pore-pairs on each side, 32 mm. long, 15 mm. wide at middle, and 16.5 mm. wide half way between middle and tip; median area, 9 mm. and 10 mm. at the same two points respectively; hence poriferous areas about 3 mm. across where widest; petal open by fully 5 mm. Anterior petals somewhat shorter and wider, about 30 by 18 mm., not quite so open at tip. Posterior petals as long as unpaired and as broad as anterior; open by about 4 mm. Periproct 3 mm. from margin about 5 mm. across, covered with numerous small, miliary bearing plates.

Primary spines of aboral surface, rather slender, perfectly smooth, about 2 mm. long; on oral surface, primaries longer especially about mouth where they are 4 mm. long. Miliary spines cylindrical or terete, not peculiar, but

[1] ὠχρός = pale, sallow, in allusion to its light yellow-brown color.

slender and very numerous. Pedicellariae common; tridentate have valves .15–.80 mm. long with rather broad blades, like those of *rotundus* (Pl. 123, fig. *27*); ophicephalous have heads about .20 mm. long; triphyllous have valves about .06 mm. long, somewhat narrower apparently than in *rotundus* (Pl. 123, fig. *25*).

Color aborally, yellowish brown; orally reddish brown; primary spines near mouth with a very faint dusky band about middle. Color in life not known; the description is from a specimen dried after forty years in alcohol.

A second larger specimen is 112 mm. long, 92 mm. wide, 30 mm. high, with mouth sunken 15 mm. The color is not essentially different but the dusky band on the oral primaries is more distinct. The test margin is 11 mm. thick or about .10 test-length.

Both specimens were collected at Acapulco, Mexico, by the HASSLER expedition in 1872.

These specimens bear no other label than "Clypeaster" and were apparently never identified by Mr. Agassiz. The form and color distinguish them so easily from the numerous specimens of *speciosus* which I have seen from Lower California that I have been unwilling to consider them that species, although no other differences of importance have been found. More material may show that *ochrus* is only a local form of *speciosus* but for the present it seems better to consider them distinct.

Clypeaster speciosus.

Verrill, 1870. Amer. Journ. Sci., ser. 2, **49**, p. 95.

Plates 122, fig. *11*; 128, fig. *7*; 135, figs. *1*, *2*; 136, fig. *5*.

Although Mr. Agassiz considered this species identical with the following, the differences between them are very constant and I cannot refuse to recognize each as a valid species. The difference in tuberculation of the test is well shown on Pl. 128, in figs. *4* and *7*. Neither primary nor miliary spines in *speciosus* are peculiar. Pedicellariae are common and all three kinds occur; they are similar to those of *rotundus*, except that the valves of the triphyllous seem to be a little more elongated in proportion to their width.

The ALBATROSS collected *speciosus* at the following points: —

Station 2824. Gulf of California, 24° 22′ 30″ N., 110° 19′ 30″ W. 8 fms. Brk. sh.

Station 2826. Gulf of California, 24° 12′ N., 109° 55′ W. 9.5 fms. Sh.
Station 2828. Gulf of California, 24° 11′ 30″ N., 109° 55′ W. 10 fms. Sh.
Bathymetrical range, 8–10 fms.
Three specimens.

Clypeaster australasiae, comb. nov.

Echinanthus australasiae Gray, 1851. Proc. Zool. Soc. London, p. 34.
Echinanthus testudinarius A. Agassiz, 1872. Rev. Ech., pt. 1, p. 106. H. L. Clark, 1909. Mem. Austr. mus., **4**, p. 558.
Plesianthus testudinarius Duncan, 1889. Journ. Linn. Soc. Zool., **23**, p. 155.

Plates 128, fig. *4;* 134, figs. *1–3;* 135, fig. *6.*

This species is apparently confined to the Southeastern coasts of Australia, for there are as yet no reliable records from elsewhere. The spines show no peculiarities. The pedicellariae are very scarce and show no characteristic features. Only one ophicephalous, and half a dozen tridentate were found; the head of the former was about .40 mm. long, while the valves of the tridentate ranged from .15 to .85 mm.

Clypeaster japonicus.

Döderlein, 1885. Arch. f. Naturg., **51**, 1, p. 100.

Clypeaster clypeus Doderlein, 1885. Arch. f. Naturg., **51**, 1, p. 100.
Clypeaster excelsior Doderlein, 1885. Arch. f. Naturg., **51**, 1, p. 101.
Plesianthus ogasawaraensis Yoshiwara, 1898. Ann. Zool. Jap., **2**, p. 60.

Plates 128, fig. *5;* 136, figs. *2–4;* 138, fig. *5.*

This seems to be the common clypeastroid of Japanese waters. Although it has usually been confused with one or the other of the two preceding species, it is really quite distinct. It is rather variable, particularly in the form of the test (compare Pl. 136, figs. *2–4*, with Pl. 138, fig. *5*) and this has led to the description of the several species mentioned in the synonymy. With Yoshiwara's type specimen of *Plesianthus ogasawaraensis* at hand for comparison I see no reason for doubting that it is *japonicus*. The color differences have wholly disappeared in alcohol and even in life are not very striking, so that I cannot feel they are of much importance. As I have stated above (p. 21), Dr. Döderlein has very kindly loaned me specimens of his Japanese species and we are agreed in considering *clypeus* and *excelsior* as synonyms of *japonicus;* they are based

on individual variants. In regard to retaining the name *japonicus* instead of *clypeus*, which precedes it on the page, the choice is determined by the fact that *clypeus* is based on a single *atypical* specimen while *japonicus* is based on a series of specimens. Moreover the name *japonicus* is to be preferred, as more appropriate. As the International Code simply recommends the adoption of "page precedence" "other things being equal," I have thought best to retain *japonicus*, as other things are not equal.

In conclusion, it may be mentioned that the primary spines are smooth and the miliaries are club shaped. Pedicellariae are abundant but no triphyllous were noted. Many tridentates are very small, the valves less than .15 mm. long, but they range up to 1.10 mm.; the valves show an equal diversity in slenderness, the length of the heads ranging from 1.5 to 2.25 times its thickness at base. The ophicephalous pedicellariae occur chiefly near the ambitus and have heads .30 mm. long, more or less.

Clypeaster lytopetalus.[1]

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 248.

Plates 124, figs. *1*, *2*; 138, figs. *1–3*.

Length, 33 mm.; breadth, 26 mm.; height, 10 mm.; mouth sunken 3.5 mm. below sides of test. Test evenly convex, sloping uniformly from ambitus to apex. Tuberculation of test rather coarse, about a hundred primary tubercles to a sq. cm. of surface; these tubercles are relatively large with sunken areolae; ridges between pore-pairs of unpaired petal, with only one primary tubercle or none; miliary tubercles numerous but very small and often only faintly indicated. Madreporite pentagonal, 1.5 mm. across; ocular plates and pores distinct but genital pores wanting. Unpaired petal, with thirty-six pairs of pores on each side, 10 mm. long, 5 mm. wide at middle and 6 mm. wide, half way between middle and tip; median area 3 and 4 mm. wide at same two points respectively; hence poriferous areas are about 1 mm. across where widest; petal open by fully 2.5 mm. Anterior petals only 8 mm. long, but 6 mm. wide, closed at tip. Posterior petals 9.5 mm. long and 6 mm. wide, slightly open at tip. Periproct very near margin about 2 mm. across, covered with 25–30 plates, most of which bare one miliary spine (rarely two).

Primary spines, smooth, slender; on aboral surface hardly more than a

[1] λύτο from λύω = to open + πέταλον = petal, in reference to the open, unpaired petal.

millimeter long, but aborally two to three times that. Miliaries very slender, not at all club shaped. Pedicellariae fairly common, but no triphyllous were found. Ophicephalous have heads about .35 mm. long. Tridentate (Pl. 124, fig. 1) have heads about .70 mm. long, the blade of the valves abruptly expanded near tip (Pl. 124, fig. *2*).

Color dark yellowish brown, in the holotype, dried from alcohol. A second smaller specimen is bright reddish brown.

The holotype is from Station 3962.

The difference in the shape of the test between this species and the next is very noticeable. The absence of genital pores even in the larger specimen shows that we have as yet only young individuals of *lytopetalus*. As genital pores are present in specimens of *reticulatus* when they are 15 mm. long, or about one third grown, it is possible the adult of *lytopetalus* reaches a length of at least 100 mm.

The ALBATROSS took *lytopetalus* at the following places:—

Station 3936. Off Laysan Island, Hawaiian Islands. Bott. temp. 68°. 79–130 fms. Sml. brk. sh., corln.

Station 3962. Off Laysan Island, Hawaiian Islands, Bott. temp.? 16 fms. Wh. s., co.

Two specimens.

Clypeaster reticulatus.

Echinus reticulatus Linné, 1758. Sys. Nat. ed. 10, p. 666. (pars).
Echinodiscus reticulatus Leske, 1778. Add. ad Klein, p. 143.
Clypeaster reticulatus Desmoulins, 1837. Études sur les Éch.: Tab. Syn. p. 214.
Clypeaster scutiformis Lamarck, 1816. Anim. sans Vert., **3**, p. 14. A. Agassiz, 1872. Rev. Ech., pt. 1, p. 101, *et auct. seq.*

Plate 124, figs. *3–6*.

Although this is one of the best known species of the genus nothing has hitherto been published concerning the spines and pedicellariae, except de Meijere's account in his report on the SIBOGA Echini (1904). While there is little to add to that account, it is worth while to call attention to the variability of the tridentate pedicellariae not only in size but in the shape of the valves. De Meijere says the valves range from .075 to .375 mm.; those I have examined range from .30 to .60 mm. In a specimen from Reunion the blade is much widened and rounded at tip (Pl. 124, fig. *3*) but in a superb specimen from Mauritius, it is less widened and is distinctly pointed (Pl. 124, fig. *4*). In a young

specimen from Hawaii, the form is somewhat intermediate between these two (Pl. 124, fig. *5*), while in an adult Hawaiian specimen the blade is more gradually expanded than in any of the others (Pl. 124, fig. *6*). The difference between this latter and the form found in the specimen from Reunion led me at first to suppose they were different species but thorough examination of their other characters and examination of the tridentate pedicellariae in a number of other specimens compelled me to conclude that in this species these pedicellariae are very variable. The two specimens from Mauritius are notable, not only for their peculiar pedicellariae but for their size; the larger is 73 mm. long, 59 mm. wide, 19 mm. high and the margins of the test are 16 mm. thick. In the Revision 48 mm. is given as the maximum length for the species.

The Albatross collected this species at numerous stations in the Hawaiian Islands, but most of the specimens are young and a good many are bare tests They range from 13 to 45 mm. in length.

Station 3846. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands. Bott. temp. 71.5°. 60–64 fms. Crs. br. s., sh., gr.

Station 3847. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. ? 23–24 fms. S., st.

Station 3848. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 71.1°. 44–73 fms. S., gr.

Station 3849. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 67.6°. 43–73 fms. Crs. s., brk. sh., co.

Station 3850. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 71.7°. 43–66 fms. Crs. s., brk. sh., co.

Station 3863. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 60°–61°. 127–154 fms. Brk. co., crs. g., r.

Station 3871. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp.? 13–43 fms. Fne. wh. s.

Station 3872. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 74.6°. 32–43 fms. Yl. s., p., co.

Station 3874. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 75.3°. 21–28 fms. S., p., sh.

Station 3876. Off Lahaina Light, Maui, H. I. Bott. temp. 74°. 28–43 fms. S., g.

Station 3962. Off Laysan Island, H. I. Bott. temp.? 16 fms. Wh. s., co.

Station 3982. Off Nawiliwili Light, Kauai, H. I. Bott. temp. 48.5°. 233–400 (?) fms. Crs. br. co., s., sh.

Station 3987. Off Hanamaulu, Kauai, H. I. Bott. temp. 73°. 50–55 fms. Crs. co. s., co. frgs.

Station 4031. Off Diamond Head, Oahu, H. I. Bott. temp. ? 27–28 fms. Fne. co. s., for., co.

Station 4032. Off Diamond Head, Oahu, H. I. Bott. temp. ? 27–29 fms. Fne. co. s., for.

Station 4033. Off Diamond Head, Oahu, H. I. Bott. temp. ? 28–29 fms. Fne. co. s., for.

Station 4034. Off Diamond Head, Oahu, H. I. Bott. temp. ? 14–28 fms. Fne. co. s., for.

Station 4061. Off Kauhola Light, Hawaii, H. I. Bott. temp. ? 24–83 fms. Co. s., corln. nod., for.

Station 4128. Off Hanamaulu, Kauai, H. I. Bott. temp. 47.8°. 68–253 fms. Crs. br. co. s., for.

Station 4146. Off Modu Manu, H. I. Bott. temp. 78.7°. 23–26 fms. Crs. co. s., for.

Station 4148. Off Modu Manu, H. I. Bott temp. 77.9°. 26–33 fms. Co. s., for.

Station 4150. Off Modu Manu, H. I. Bott. temp. 74°. 71–160 fms. Co.

Station 4158. Off Modu Manu, H. I. Bott. temp. 78.6°. 20–30 fms. Co., corln.

Station 4164. Off Modu Manu, H. I. Bott. temp. 78.1°. 40–56 fms. Co. s., p., sh.

Wotje, Marshall Islands.

Taritari, Gilbert Islands.

Bathymetrical range, 13–253 fms. Extremes of temperature, 78.7°–47.8°.

One hundred and seventy-one specimens.

Clypeaster humilis.

Echinanthus humilis Leske, 1778. Add. ad Klein, p. xix, 121.

Clypeaster humilis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 100.

Clypeaster placunarius Agassiz and Desor, 1847. Ann. Sci. Nat., ser. 3, **7**, p. 130: non *Scutella placunaria* Lamarck, 1816.

Clypeaster rosaceus Lovén, 1887. Bih. K. Svenska Vet.-Akad. Handl., **13**, afd. 4, no. 5, p. 173: non *Echinus rosaceus* Linne, 1758, *Clypeaster rosaceus* Lamarck, 1801.

Alexandria magnifica Pfeffer, 1881. Verh. Naturw. Ver. Hamburg-Altona im 1880, p. 64.

Plates 123, fig. *23;* 137; 138, fig. *4*.

Although this is very possibly the best known species in the genus, its name

is difficult to determine and it is only after much deliberation that I have decided to use the name first given by Leske and later used by Mr. Agassiz in the Revision. It seems to be true that in a general way *Echinanthus humilis* Leske is a synonym of *Echinus rosaceus* Linné but as soon as Lamarck in 1801 definitely restricted *rosaceus* to the West Indian form with which that name has since been associated, *humilis* was no longer synonymous with it except in small part and hence it is permissible to use *humilis* for one of the forms included by Leske under that name. Certainly Lovén seems to be wrong in attempting to apply Linné's name *rosaceus* to this species, since Lamarck long ago restricted it to the West Indian form, but he seems to be quite right in maintaining that Lamarck's *Scutella placunaria* is not a Clypeaster at all and therefore the name *placunarius* cannot be correctly used for this species, even if we reject *humilis*. Dr. Döderlein tells me, and I am quite ready to agree with him, that Pfeffer's *Alexandria magnifica*, which has been a puzzle to systematists, is based on a fine alcoholic specimen of this Clypeaster.

The abactinal primary spines of this species tend to be small, rough, and slightly enlarged near the tip; the miliaries are not peculiar. Pedicellariae seem to be quite rare for on one specimen, one ophicephalous pedicellaria was all I could find and there were no tridentate, while on another specimen, tridentate were found but not an ophicephalous. The head of the ophicephalous was about .40 mm. long and the loops on the valves, particularly on the largest, were remarkably big (Pl. 123, fig. *23*). The valves of the tridentate are about .90 mm. long, narrow but broadly expanded at tip somewhat like fig. *2*, Pl. 124. The known geographical range of *humilis* is from the Red Sea and Mauritius to the East Indian Islands.

Clypeaster prostratus.

Scutella gibbosa Ravenel, 1845. Proc. Acad. Nat. Sci. Philadelphia, **2**, p. 253, non Risso, 1826, Hist. Nat., p. 284.

Clypeaster prostratus Ravenel, 1848. Ech. Rec. Foss. South Carolina, p. 3.

Clypeaster subdepressus A. Agassiz, 1872. Rev. Ech., pt. 1, p. 101 (pars); Pl. xi°, figs. 1, 2.

Examination of two fine specimens in the M. C. Z. collection, one from South Carolina and one from Georgia, has satisfied me that this species is perfectly distinct from the West Indian *subdepressus*. The form of the test and the appearance of the petals are very characteristic features, well shown in Mr. Agassiz's figures. The spines and pedicellariae are similar to those of *subdepressus* except that the tridentate are the only pedicellariae found and their valves are

broader, straighter, and more acuminate than those of *subdepressus;* their length is .35–1.00 mm. In 1911 (Ann. Mag. Nat. Hist., ser. 8, **7**, p. 595) I named this species as the type of Agassiz's genus Stolonoclypus should it ever be desirable or necessary to use that genus, and added that *prostratus* was a synonym of *subdepressus.* It now seems that *prostratus* can stand on its own merits and hence is itself the type-species of Stolonoclypus.

Clypeaster rotundus.

Stolonoclypus rotundus A. Agassiz, 1863. Bull. M. C. Z., **1**, p. 25.
Clypeaster rotundus A. Agassiz, 1872. Rev. Ech., pt. 1, p. 100.

Plates 122, figs. *5–7;* 123, figs. *25–27;* 128, fig. *6;* 132; 133.

This fine species is the West coast representative of *prostratus* and is really nearer that species than it is to *subdepressus.* It is readily distinguished from the other West coast species by the shape of the petals and the fine tuberculation of the test (Pl. 128, fig. *6*). The Albatross took a single specimen of *rotundus* at Station 2796, Gulf of Panama, 33 fms., and as it is a particularly fine one, and the species has never been figured, I have given here photographs of it (Pls. 132, 133).

The primary spines of *rotundus* are more or less rough or serrulate, and the abactinal ones (Pl. 122, figs. *5*, *6*) are slightly expanded at tip. The miliary spines (Pl. 122, fig. *7*) are cylindrical or terete. Pedicellariae seem to be sometimes very scarce, as in one specimen only three minute tridentate and one triphyllous were found. The valves of the tridentate (Pl. 123, figs. *26*) are only about .15 mm. long and are notably broad. In another specimen there were a number of tridentate pedicellariae with valves over .60 mm. long and a more usual style of blade (Pl. 123, fig. *27*). In a third specimen, ophicephalous pedicellariae were found but they showed no peculiarities.

Clypeaster subdepressus.

Echinanthus subdepressa Gray, 1825. Ann. Phil., **26**, p. 427.
Clypeaster subdepressus Agassiz, 1836. Mem. Soc. Sci. Nat. Neuchatel, **1**, p. 187.

Plate 123, figs. *11*, *12*.

The presence of quadridentate pedicellariae (Pl. 123, figs. *11*, *12*) is one of the characteristics of this West Indian species. The valves of these pedicellariae are .45–1.00 mm. long and very narrow, but slightly expanded at the tip. The

tridentate pedicellariae are smaller and are quite rare, as are the ophicephalous, with heads about .30 mm., and the triphyllous, whose valves are only .075 mm. long.

A specimen of *subdepressus* in the M. C. Z. collection is the largest clypeastroid I have seen or found recorded; it is 248 mm. long and 214 mm. wide. It is labelled "*Lagana latissima* Blainville" and is probably identical with Lamarck's *Scutella latissima*, in which case that name is synonymous with *subdepressus* rather than with *humilis*.

Clypeaster virescens.

Döderlein, 1885. Arch. f. Naturg., **51**, 1, p. 102.

Plates 122, fig. *15;* 123, figs. *28–31;* 128, fig. *8;* 139, fig. *4;* 140, figs. *1–2*.

This is a remarkably well characterized species which has not hitherto been figured. The series of specimens collected by the Albatross ranges from 13 to 112 mm. in length. All have the characteristic yellow-green color, though the depth of the shade differs much in different specimens. The primary spines are nearly smooth, but under high magnification the marginal ones show some serrations (Pl. 122, fig. *15*). The miliaries are mostly more or less club shaped. Some of the actinal primaries, especially those near margin are 4–5 mm. long. Ophicephalous and tridentate (Pl. 123, fig. *29*) pedicellariae are abundant. The former have heads .40–.50 mm. long; the blades have wide, low, curved openings (Pl. 123, fig. *28*) while the loops are often, or of the largest valve always, more or less bihamate (Pl. 123, figs. *30, 31*). The tridentate valves range from .25–1.00 mm. in length; they are rather straight and compressed and the blades meet at tip for half their length.

This species is known only from Japanese waters. The Albatross collected it at the following places:—

Station 4877. Eastern Channel, Korea Strait. Bott. temp. ? 59 fms. Fne. gy. s., brk. sh.

Station 4884. Between Nagasaki and Kagoshima, Japan. Bott. temp. 61.7°. 53 fms. Dk. gy. s., brk. sh.

Station 4885. Between Nagasaki and Kagoshima, Japan. Bott. temp. 61.7°. 53 fms. Dk. gy. s., brk. sh.

Station 4893. Southwest of Goto Islands, Japan. Bott. temp. 55.9°. 95–106 fathoms. Gy. s., brk. sh., p.

Station 4894. Southwest of Goto Islands, Japan. Bott. temp. ? 95 fms. Gy. s., brk. sh., p.

Station 4895. Southwest of Goto Islands, Japan. Bott. temp.? 95 fms. Gy. s., brk. sh., p.

Station 4937. Kagoshima Gulf, Japan. Bott. temp. 64.8°. 58 fms. M., lava, p.

Station 4948. Between Kagoshima and Kobe, Japan. Bott. temp. 62.6°. 65 fms. Dk. gy. vol. s., brk. sh., p.

Station 5071. In Suruga Gulf, Japan. Bott. temp. 70.8°. 87 fms. Char. of bott.?

Station 5095. Gulf of Tokyo, Japan. Bott. temp. 57.8°. 58 fms. Fne. bl. s., br. sh.

Bathymetrical range, 53–106 fms. Extremes of temperature 70.8°–55.9°. Fourteen specimens.

Clypeaster leptostracon.[1]

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 248.

Plates 122, figs. *8*, *9;* 123, figs. *17–20;* 135, figs. *3–5*.

Length 38 mm.; breadth, 31 mm.; height, 7.5 mm.; mouth sunken but very little below the sides of the test. Test quite flat distal to petals, the margin a trifle thicker than the test a little ways in from the margin; petaloid area abruptly elevated; orally the test is flat, the region about the mouth slightly concave. Tuberculation of test sparse; primary tubercles relatively large with sunken areolae, less than 100 to a square centimeter of test surface, aborally; ridges between pore-pairs of unpaired petal with no primaries or occasionally a single one; miliary tubercles fairly numerous, not crowded and rather evenly distributed. Madreporite pentagonal, 2 mm. across, the ocular plates and pores fairly distinct; genital pores present only in interambulacra 2 and 4, close to madreporite. Unpaired petal with 24 pore-pairs on each side, 9 mm. long, 5.5 mm. wide near tip, open by more than 3 mm.; median area 3–3.5 mm. wide; poriferous areas thus 1 mm. wide each. Anterior petals 7.5 mm. long, open by only 1 mm., their greatest width, 4.75 mm., a little further from tip than in unpaired petal. Posterior petals 8.5 mm. long, 5 mm. wide, open by about 2 mm., their form much like that of unpaired petal. Periproct 2 mm. from margin, about 2 mm. across, covered with miliary bearing plates.

[1] λεπτός = delicate + ὄστρακον = shell, in allusion to the thinness of the test-wall.

Primary spines smooth and pointed (Pl. 122, fig. *9*), some of the marginal, actinal ones nearly 3 mm. long. Miliary spines usually club shaped (Pl. 122, fig. *8*), but many are not evidently so. Pedicellariae only fairly common and not particularly characteristic. Triphyllous (Pl. 123, fig. *18*), very small with valves only .06 mm. long. Ophicephalous (Pl. 123, fig. *17*) with heads .25–.30 mm. long and rather slender valves. Tridentate (Pl. 123, fig. *20*) with straight valves, more or less in contact, and ranging from .10 to .60 mm. in length; the larger ones (Pl. 123, fig. *19*) have the blade expanded rather abruptly near tip and the margin serrate; there is often a more or less imperfect loop on the base of these valves.

In color the specimens (in alcohol) vary from bright yellow or reddish yellow to dirty purplish white; in dry specimens the colors are duller. The yellow specimens have a large number of rather indistinct, dusky blotches on the aboral surface; these are arranged in pairs, four pairs in each ambulacrum and interambulacrum, and form four concentric circles around the petals, parallel to the ambitus. In all the specimens there is more or less contrast in color between the ambulacra and interambulacra on the oral surface. The colors in life are not essentially different.

The holotype is from Station 4046.

When young specimens of *virescens* of the same length as the type of *leptostracon* are compared with it, the differences in the form of the petals and especially in the form of the test are very marked. The difference in color is also marked. There is no doubt that the two species are perfectly distinct. The series of *leptostracon* at hand is a very complete one, the specimens ranging from 5.5 mm. in length up to the type, which is seven times as large. In specimens under 15 mm. in length the aboral side of the test has numerous deep, irregular pits in the surface; in the smallest specimen these occur everywhere except close to the madreporite, but as the petaloid area grows, the pits are confined more and more to the marginal part of the test and they finally disappear altogether. In the youngest specimen, there are but three or four pore-pairs in each petal and the resemblance to Echinocyamus is marked but there are at least ten madreporic pores, instead of the one, characteristic of that genus.

The Albatross took *leptostracon* at the following places:—

Station 3823. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands. Bott. temp. 69°. 78–222 fms. Fne. s., p.

Station 3987. Off Hanamaulu, Kauai, H. I. Bott. temp. 73°. 50–55 fms. Crs. co. s., co. frgs.

Station 4046. Off Kawaihae Light, Hawaii, H.I. Bott. temp. 59°. 71–147 fms. Co. s,, for.

Station 4064. Off Kauhola Light, Hawaii, H. I. Bott. temp. 69°. 63–107 fms. Vol. s., for., co.

Station 4066. Off Ka Lae-o Ka Ilio Point, Maui, H. I. Bott. temp. 52.5°. 49–176 fms. Rky.

Bathymetrical range, 49–222 fms. Extremes of temperature, 73°–52.5°. Fifty-seven specimens.

Clypeaster lamprus,[1] nom. nov.

Clypeaster latissimus A. Agassiz, 1883. Mem. M. C. Z., **10**, p. 41. Non *C. latissimum* A. Ag., 1872. Rev. Ech. pt. 1, p. 101.

Plates 122, figs. *1–4;* 123, figs. *21*, *22*.

This is one of the best defined and most easily recognized species in the genus but as it is certainly not the *Laganum latissimum* of Agassiz and Desor, 1847, it cannot be called "*Laganum latissimum* Hupé, 1856," even if it be granted that Hupé had specimens of this species as the basis for his name. And it is almost certain that Hupé never saw this species which was collected by the Blake at five stations in the Lesser Antilles in 88–120 fms. The figures given by Mr. Agassiz (1883, Mem. M. C. Z., **10**, pls. XV^{b}, fig. 3; and XV^{c}, fig. 3) show the characteristic features admirably, but certain additional details deserve mention.

The abactinal primaries are smooth, pointed and many, especially of the larger ones near apex of test, tend to be spatulate. The actinal primaries are more diversified; the small ones (Pl. 122, fig. *4*) are often curved, while the larger ones may be doubly curved (Pl. 122, fig. *2*) and spatulate (Pl. 122, fig. *3*) and the largest, which may be 10–12 mm. long, are curved and broadly expanded at tip (Pl. 122, fig. *1*). Pedicellariae are very common; the triphyllous are very small with valves only .07 mm. long while the ophicephalous have heads .40 mm. long, with valves much like those of *virescens*. The tridentate pedicellariae are of two kinds although these intergrade to some extent; the small ones (Pl. 123, fig. *21*) are not peculiar or characteristic, but the large one, with curved valves up to .80 mm. in length (Pl. 123, fig. *22*), are unlike any that are known in other Clypeasters; the blade has the margins much incurved, thus tending to become tubular and the valves meet only at the tip.

[1] λαμπρός = splendid, magnificent.

ARACHNOIDIDAE Gregory.

This family is maintained for a single, monotypic genus, remarkable for the flatness of its test, the divergent petaloid areas, the supramarginal periproct, the separate auricles and a plated buccal membrane.

Arachnoides.

Leske, 1778. Add. ad Klein, p. viii and p. 154.

Type, *Arachnoides echinarachnius* Leske, *l. c.*, = *Echinus placenta* Linné, 1758. Sys. Nat., ed. 10, p. 666.

(For a discussion of the nomenclatural questions involved in dating this genus from Leske, see Clark, 1911, Ann. Mag. Nat. Hist., ser. 8, 7, p. 598).

Arachnoides placenta.

Echinus placenta Linné, 1758. Sys. Nat., ed. 10, p. 666.
Arachnoides placenta Agassiz, 1841. Mon. Scut., p. 94.

Plate 125, figs. *1–3*.

Little need be said of this well-known species, but attention may well be called to the fact that the pedicellariae which are very scarce and which de Meijere calls tridentate, in reality have only *two* valves (Pl. 125, fig. *2*); these valves measure .12–.25 mm. in length, are rather broad (Pl. 125, fig. *1*) and are serrate and toothed at tip (Pl. 125, fig. *3*) where they meet. Many spines, especially among the abactinal primaries, have asymmetrical swollen tips like that figured by de Meijere (1904) for Echinodiscus. The geographical distribution of Arachnoides is remarkable for while it is common in New Zealand as far south as Dunedin, and on the Australian coast, and reaches Samoa on the east and the Malay Peninsula and Burmah on the north, it is not known from either the western or the northeastern parts of the Indo-Pacific region. Very few echinoderms are common to the Malay Peninsula and New Zealand, and no other case is satisfactorily demonstrated.

LAGANIDAE A. Agassiz.

Although the superficial resemblance of the members of this family to Clypeaster is marked, more careful examination shows that the differences are far more important and indicate that there is no very close relationship. The

test of the Laganidae is usually very flat and it is never highly arched although it is occasionally moderately thick and concave beneath. The primary spines are not peculiar, but are solid, slender, and pointed, while the secondaries are characteristic, as already described (p. 14). All three kinds of pedicellariae are present but are not usually distinctive.

Although reported from Zanzibar, Madagascar, and the Persian Gulf, the family is characteristic of the East Indies and Southeastern Japan. It is not represented in the Atlantic or Eastern Pacific Oceans. The grouping of the species in genera has been a source of no little difference of opinion among students of the family, owing to a belief that the number of genital pores is variable, some individuals having four and some five, even in the same species. After examining hundreds of specimens of at least twelve species, I feel satisfied that the number of genital pores is a very constant character and serves very well to distinguish two genera within the family.

Key to the Genera of Laganidae.

Genital pores 5 or 6, present in all interambulacra . . . . . *Laganum.*
Genital pores 4, wanting in posterior interambulacrum . . . . . *Peronella.*

Laganum.

Gray, 1825. Ann. Phil., **26**, p. 427. (*Lagana* by error).

Type, *Echinodiscus laganum* Leske, 1778. Add. ad Klein, p. 140.

In de Meijere's very careful and admirable revision of this genus (Siboga Ech., p. 113–131), no attempt is made to group the species in subgenera or to separate a genus Peronella, though there is a brief discussion of some of the points involved. In his key, de Meijere uses the *position* of the genital pores as a primary mark of distinction, between the species; while I do not question its importance, I am inclined to think the *number* is a more fundamental character. He further points out important characters in the position, form and covering of the periproct, to which earlier writers had paid small heed. His interesting discoveries in regard to the spines have already been discussed (p. 14). Of his four new species, I think two must be referred to the very variable *L. fudsiyama*, although further study on still more abundant material may show that I am quite wrong. For the present, I recognize six species of Laganum.

Key to the Species of Laganum.

Genital pores at proximal ends of interambulacra, more or less close to madreporite.
- Anus midway between margin and mouth, longitudinally elongated; test thick, with depressed petaloid area and swollen margins . . . . . *laganum.*
- Anus distinctly nearer to margin than to mouth, usually transversely elongated; test with petaloid area more or less elevated and margins not swollen.
  - Petaloid area relatively large, its total length .60 test-length or more; test with more or less pentagonal ambitus, its length usually decidedly greater than breadth . . . . . *depressum.*
  - Petaloid area relatively small, its total length .50 test-length or less; test with decagonal or rounded ambitus, its length little, or not at all, exceeding breadth.
    - Petals small but relatively broad, with curved poriferous areas, converging to the nearly or quite closed tip; test low, v. d. .13–.18 test-length . *decagonale.*
    - Petals narrow, poriferous areas little curved and tips widely open.
      - Test relatively high, v.d. ranging from .20 to .40 test-length; posterior interradius with one genital pore; tuberculation of test rather coarse (within a petal 10 mm. long there are about 20–25 primary tubercles and in one 15 mm. long, there are about 40–50) . . . . . *fudsiyama.*
      - Test lower, v.d. less than .20 test-length; two genital pores generally present in posterior interradius; tuberculation of test finer (within a petal 10 mm. long, there are 40–50 primary tubercles and in one 15 mm. long, there are 80–90) . . . . . *diploporum*

Genital pores in interambulacra, some distance from madreporite . . . . . *putnami*

Laganum laganum.

Echinodiscus laganum Leske, 1778. Add. ad Klein, p. 140.
Lagana laganum de Blainville, 1830. Dict. Sci. Nat., **60**, p. 196.

Plate 124, fig. *17*.

The tridentate pedicellariae of this species are rather characteristic and as they have never been figured, I have thought it desirable to show one valve (Pl. 124, fig. *17*). The geographical range of *L. laganum* is from the Philippine Islands, east to the Carolines, and southward to Tasmania.

Laganum depressum.

Agassiz, 1841. Mon. Scut., p. 110.

Plate 124, figs. *7–12*.

So far as I can judge from his description, the Laganum, which Mazzetti (1895, Mem. Reg. Accad. Sci. Modena, ser. 2, **10**, p. 217) described as new under the name *fragile*, is simply one of this species.

The pedicellariae are not very common but are rather characteristic. The ophicephalous have heads .30–.35 mm. long; the blade (Pl. 124, fig. *9*) has coarsely serrate margins; the loops differ very much on the three valves (Pl. 124, figs. *10–12*). The tridentate have slender, bent valves (Pl. 124, figs. *7*, *8*) about .40 mm. long. The miliary spines examined by me had square-cut tips, not sloping as figured by de Meijere, but this may be a matter of the place on the test, whence the spine is taken.

The ALBATROSS brought home three bleached bare tests of this species, collected at Wotje, Marshall Islands, 22 January, 1900.

Laganum decagonale.

Scutella decagonalis de Blainville, 1827. Dict. Sci. Nat., **48**, p. 229.
Peronella decagonalis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 148.
Laganum decagonale Bell, 1884. Alert Ech., p. 122.

The exact geographical range of this species is uncertain owing to its having been confused with others. Specimens are in the M. C. Z. collection from the Arafura Sea (CHALLENGER coll.), the Philippine Islands, and "Durban, Natal." The last was purchased from a European dealer and the locality cannot be considered as unimpeachable, although there is no obvious reason for questioning it.

Laganum fudsiyama.

Döderlein, 1885. Arch. f. Naturg., **51**, 1, p. 104.

Plates 124, figs. *13–16;* 127, figs. *7*, *8;* 140, figs. *3*, *4;* 141, figs. *4–9*.

The large series of Laganum collected by the ALBATROSS has proven a source of much interesting study, but no little perplexity, owing to the great diversity shown in the height of the test and in the number of genital pores. The conclusion was finally reached that the former is a very variable and unimportant character while the latter is a very constant and useful one. Dr. Döderlein has been so good as to send me authentic specimens of *fudsiyama* from Japan, so I have no doubt as to the authenticity of my Japanese specimens. These specimens range in length from 50 to 71 mm., while those from the Hawaiian Islands range from 8 to 50. The latter are as a rule much higher than the former but owing to the absence of small specimens from Japan, I cannot decide whether the height is a youthful character or not. So far as I can see de Meijere's *L. conicum* is identical with *fudsiyama* and apparently his *L.*

solidum is also; the Hawaiian specimens which Mr. Agassiz and I had referred to *solidum* are almost certainly *fudsiyama* but it is possible that de Meijere's East Indian specimens are identical with our species *diploporum*.

The color of *fudsiyama* is usually green (at least in alcoholic and dry specimens) but ranges from grayish yellow to rich, deep green. In the Hawaiian specimens, the ambulacra on the actinal side are often more or less colored with dark purplish brown, the contrast between ambulacra and interambulacra being frequently very marked (Pl. 141, fig. *9*). The miliary spines are as de Meijere has figured them for *conicum* except that those I examined had square-cut, and not sloping, tips; the rods (Pl. 124, fig. *14*) widen gradually and are coarsely serrate at tip. Pedicellariae common; ophicephalous like those of *depressum*, the head setting into a hollow at the top of the stalk (Pl. 124, fig. *13*). The tridentate pedicellariae are of two kinds; in one the valves (Pl. 124, fig. *15*) are only .20–.25 mm. long and have a broad rather flat blade; in the other, the valves (Pl. 124, fig. *16*) are .35–.45 mm. in length, curved as in *depressum*, and have a mesh-work in the blade. The tuberculation of the test is rather coarse, as is shown in figs. *7* and *8*, Pl. 127.

The large series of specimens examined came from the following ALBATROSS stations. Many of them are bare and waterworn and some are not certainly identifiable.

Station 3700. Off Seno Umi, Honshu, Japan. Bott. temp. ? 63 fms. Vol. m., s.

Station 3748. Off Suno Saki, Honshu, Japan. Bott. temp. ? 73–200 fms. Yl. s., rot. co.

Station 3811. Off Honolulu Light, Oahu, Hawaiian Islands. Bott. temp. 70.5°. 52–238 fms. Co. s., r.

Station 3814. Off Diamond Head, Oahu, H. I. Bott. temp. 46°. 42–284 fms. Co. s., sh., st.

Station 3838. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 67°. 92–212 fms. Fne. gy. br. s.

Station 3859. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 60.5°–60.2°. 138–140 fms. Fne. s., m.

Station 3863. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 61°–60°. 127–154 fms. Brk. co., crs. g., r.

Station 3876. Off Lahaina Light, Maui, H. I. Bott. temp. 74°. 28–43 fms. S., g.

Station 3984. Off Nawiliwili Light, Kauai, H. I. Bott. temp. 47°. 164–237 fms. Fne. co. s.

Station 4079. Off Puniawa Point, Maui, H. I. Bott. temp. 60.8°. 143–178 fms. Gy. s., for.

Station 4080. Off Puniawa Point, Maui, H. I. Bott. temp. 56.4°. 178–202 fms. Gy. s., for.

Station 4081. Off Puniawa Point, Maui, H. I. Bott. temp. 51.7°. 202–220 fms. Gy. s., for.

Station 4099. Off Puniawa Point, Maui, H. I. Bott. temp. 60.7°. 152–153 fms. Fne. s., for., sh.

Station 4101. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 59.7°. 122–143 fms. Co. s., sh., for.

Station 4115. Off Kahuku Point, Oahu, H. I. Bott. temp. 55.1°. 195–241 fms. Co. s., for.

Station 4122. Off Barber's Point Light, Oahu, H. I. Bott. temp. 64.6°. 192–352 fms. Crs. co. s., sh.

Station 4132. Off Hanamaulu, Kauai, H. I. Bott. temp. 46.8°. 257–312 fms. Fne. gy. s., m.

Station 4965. Between Kobe and Yokohama, Japan. Bott. temp. 49.4°. 191 fms. Dk. gr.-gy. s., sh.

Station 4966. Between Kobe and Yokohama, Japan. Bott. temp. 44.1°. 244–290 fms. Br. m., s., for.

Station 4967. Between Kobe and Yokohama, Japan. Bott. temp. 45.9°. 244–253 fms. Br. m., s., for.

Station 5091. Off Gulf of Tokyo, Japan. Bott. temp. 47.6°. 197 fms. Gn. m., crs. bk. s., p.

Bathymetrical range, 28–352 fms. Extremes of temperature, 74°–44.1°. Four hundred and sixty-six specimens.

Laganum diploporum.[1]

A. Agassiz and Clark, 1907. Bull. M. C. Z., **51**, p. 129.

Plates 127, figs. *9–12;* 142, figs. *2–4*.

So nearly related is this species to the preceding (*fudsiyama*) that a detailed description would be quite superfluous. Comparison of figs. *2–4*, Pl. 142, with those of *fudsiyama* (Pl. 141, figs. *4–7*) will make plainer than any words the

[1] Διπλός = double + πόρος = pore, in allusion to the two genital pores in the posterior interambulacrum.

difference between the two species in form; comparison of fig. *9*, Pl. 127, with fig. *7* of the same plate will reveal the difference in tuberculation; and comparison of figs. *10–12*, Pl. 127, with fig. 8 of the same plate, shows at once the curious difference in genital pores. As regards this latter character it will be noted that there is great individual diversity in the position of the posterior pair of pores with relation to each other. In typical cases, they are well separated (Pl. 127, fig. *12*), but they are often near together (fig. *11*) or even more or less merged (fig. *10*), and when they are merged into one it is often difficult, and may be impossible, to see that there are two. (Of course, it is not probable that two pores are ever merged; the probability is that in such apparent cases we have incompletely separated pores arising from a single one; *i. e.* the single pore is the primitive, the pair of pores, the derived condition). When the two pores are quite distinct, each has its own genital duct, several millimeters in length, but it is not easy to decide whether there are two distinct gonads; the appearance is more that of a single, much branched gonad with two separate ducts. The spines and pedicellariae of *diploporum* are not certainly distinguishable from those of *fudsiyama*. In coloration too, the two species are not unlike. The largest specimen of *diploporum* in the ALBATROSS collection is 50 mm. long. Specimens under 15 mm. are not certainly distinguishable from *fudsiyama* and most specimens under 20 mm. do not show *six* genital pores. All of the specimens are from Japan and were taken at the following places. Many are nearly or quite bare.

It is notable that *fudsiyama* was taken at only one of these stations.

Station 3707. Off Ose Zaki, Honshu, Japan. Bott. temp. ? 63–75 fms. Vol. s., a., g.

Station 3748. Off Suno Saki, Honshu, Japan. Bott. temp. ? 73–200 fms. Yl. s., rot. co.

Station 4885. Between Nagasaki and Kagoshima, Japan. Bott. temp. 62°. 53 fms. Dk. gy. s., brk. sh.

Station 4888. Between Nagasaki and Kagoshima, Japan. Bott. temp. 59.7°. 71 fms. Dk. gy. s., brk. sh.

Station 4893. Southwest of Goto Islands, Japan. Bott. temp. 55.9°. 95–106 fms. Gy. s., brk. sh., p.

Station 4895. Southwest of Goto Islands, Japan. Bott. temp. ? 95 fms. Gn. s., brk. sh., p.

Station 4902. Southwest of Goto Islands, Japan. Bott. temp. 52.9°. 139 fms. Gy. s., brk. sh.

Station 4904. Southwest of Goto Islands, Japan. Bott. temp. ? 107 fms. Fne. gy. s., brk. sh.

Station 4933. Off Kagoshima Gulf, Japan. Bott. temp. 56°. 152 fms. Rky.

Station 4934. Off Kagoshima Gulf, Japan. Bott. temp. 56°. 103–152 fms. Rky.

Station 4937. Off Kagoshima Gulf, Japan. Bott. temp. 64.8°. 58 fms. M., lava., p.

Station 5055. Suruga Gulf, Japan. Bott. temp. 56°. 124 fms. Gn. m., gy. s., brk. sh., p.

Station 5070. Suruga Gulf, Japan. Bott temp. 57.6°. 108 fms. M., s., brk. sh.

Station 5092. Off Gulf of Tokyo, Japan. Bott. temp. 56.3°. 70 fms. Crs. bk. s.

Bathymetrical range, 53–200 fms. Extremes of temperature, 64.8°–52.9°.

Fifty-nine specimens.

Laganum putnami.

A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 359.

Plate 142, figs. *14–16*.

Although Mr. Agassiz, in his account of this species in the Revision, refers to "figures," I can not find that any figures have ever been published. I have therefore given photographs of one of the original specimens. The species seems to be a rare one for I do not find any records in print since 1863. Döderlein failed to find *putnami* in his collecting and the Albatross took no specimens in either of her voyages. The original specimens are hardly more than bare tests and no pedicellariae were seen.

Peronella.

Gray, 1855. Cat. Recent Ech., pt. 1, p. 13.

Type, *Laganum peronii* Agassiz, 1841. Mon. Scut., p. 123.

It is interesting to find that among these Laganidae having only *four* genital pores, there is, just as in the group having five or six such pores, one species in which these pores are far removed from the apical system. In fact Gray based his subgenus Peronella on the peculiar position of the pores, although he

lays equal stress on their number. Aside from the position of the genital pores, the position of the periproct and the size and form of the petals seem to be the most important specific characters. Whether the plates which cover the periproct carry spines (miliaries) or not is also a character of some importance, and the form of the test and the thickness of its margins are also of value. In the Revision, Mr. Agassiz gives four species of Peronella but one of these (*rostrata*) seems to be identical with *orbicularis*, as Mr. Agassiz himself suggests is probable. Since the publication of the Revision, Pfeffer, Döderlein, and de Meijere have added species to the genus. Of Pfeffer's three "new" forms, *pallida* can hardly be considered a separate variety of *lesueuri*, as that species varies considerably in color; *ludwigii* is so near *orbicularis* I find no way of separating them; and *elegans* seems to be a young example of the same species. The record of *ludwigii* from St. Thomé must certainly be due to an erroneous label, for none of the family occur in the Atlantic ocean. Döderlein's two Japanese species seem to be perfectly valid and the same is apparently true of de Meijere's two from the East Indies. The species Mr. Agassiz and I described in 1907 as *Laganum strigatum* was based primarily on a specimen which proves to be a Peronella and I have therefore transferred that species to this genus. It will thus be seen that I find it desirable to recognize eight species of Peronella.

Key to the Species of Peronella.

Genital pores at proximal ends of interambulacra more or less close to madreporite.

- Anus (*i. e.* center of periproct) .15–.30 of long radius from margin.
  - Petaloid area only about .40 test-length; petals narrow, open; poriferous areas nearly parallel; anal plates without spines; test flat with thin margin (about .06 test-length) . . . . . *strigata.*
  - Petoloid area half test-length, or more; petals variable in form but rather broad, sometimes open, especially unpaired one, but usually more or less closed and pointed.
    - Margin of test thick, about .12 test-length; petaloid area, about .60 test-length . . . . . *orbicularis.*
    - Margin of test thin, about .07 test-length; petaloid area about .50 test-length. *lesueuri.*
- Anus .40–.50 of long radius from margin.
  - Height of test rather less than .20 of length.
    - Petaloid area rather less than half test-length; margin of test very thin, about .06 test-length; anal plates without spines; test about as wide as long. *pellucida.*
    - Petaloid area more than half test-length; margin of test about .09 test-length; anal plates with spines.
      - Test about nine tenths as wide as long or wider; petals open; poriferous areas little curved . . . . . *rubra.*
      - Test about four fifths as wide as long; petals closed; poriferous areas curved, converging at tip . . . . . *minuta.*

Height of test rather more than .25 of length; periproct very large, longitudinally elongated; anal plates without spines; petals very broad, short, pointed . . . *analis*.
Genital pores in interambulacra at a greater or less distance from madreporite . . . . . *peronii*.

Peronella strigata,[1] comb. nov.

Laganum strigatum A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 250.

Plate 142, figs. *11–13*.

Length, 30 mm.; breadth, 29 mm.; height, 6 mm.; margins about 1.8 mm. thick; petaloid area, 12 mm. long; petals about equal, 1.7 mm. wide, open by nearly a millimeter, as poriferous areas (12–14 pore-pairs on each side) are nearly parallel. Mouth central. Periproct, 2.5 mm. long by 2 mm. wide, situated 3 mm. from margin, covered with plates which do not carry spines. Genital pores four the posterior interambulacrum having none. Tuberculation of test moderate, including many glassy tubercles of about the same size and abundance as the primary tubercles. Sutures between plates sharp and well defined. Miliary spines with the component rods gradually widened and rather finely serrate at tip. Pedicellariae not peculiar or distinctive in any way; no triphyllous were found and tridentate and ophicephalous are not common. Color light brown with the sutures darker and more or less purple.

The holotype and only specimen is from ALBATROSS

Station 3859. Off Mokuhooniki Islet, Pailolo Channel, Hawaiian Islands. Bott. temp. 60.5°–60.2°. 138–140 fms. Fne. s., m.

In the original description of this species, specimens of *Laganum fudsiyama* were included and are referred to as having *five* pores. The species are undoubtedly nearly allied but aside from the difference in number of genital pores and in color, there is a difference in the form of the periproct, which is not elongated in *fudsiyama*.

Peronella orbicularis.

Echinodiscus orbicularis Leske, 1778. Add. ad. Klein, p. 144.
Peronella orbicularis A. Agassiz, 1872. Rev. Ech. pt. 1, p. 149.

Specimens of this species are in the M. C. Z. collection from the Persian Gulf, Philippine Islands, and Torres Strait. My observations accord with de Meijere's, except that I failed to find the tridentate pedicellariae which he figures.

[1] *Strigatus* = furrowed, in reference to the very distinct sutures between the plates.

Peronella lesueuri.

Laganum lesueuri Agassiz, 1841. Mon. Scut., p. 116.
Peronela lesueuri A. Agassiz, 1872. Rev. Ech., pt. 1, p. 148.

Plate 124, figs. *23*, *24*.

The component rods of the miliary spines do not seem quite so abruptly widened as de Meijere figures them. The triphyllous pedicellariae are fairly common and have very abruptly expanded valves (Pl. 124, fig. *23*). I failed to find (in four specimens) any ophicephalous. The tridentate are very variable, having valves ranging in length from .10 to .45 mm. One form has the valves curved in such a way (Pl. 124, fig. *24*) as to resemble "globiferous" pedicellariae and these are the most characteristic of all. This species reaches the largest size of any of the Laganidae and specimens exceeding 130 mm. in length are not rare. There are specimens in the M. C. Z. collection from Japan, Hong Kong, Singapore, Philippines, Dutch East Indies, and Queensland.

Peronella pellucida.

Peronella (**Laganum**) **pellucida** Döderlein, 1885. Arch. f. Naturg. **51**, 1, p. 104.

Plate 142, figs. *1*, *8–10*.

Döderlein gives 32 mm. as the diameter of his largest specimen, but one in the M. C. Z. collection (Pl. 142, fig. 1) is 50 mm. across. In large specimens, the test is not nearly so thin and transparent as in younger specimens although it is not as thick-walled as in related species. The miliary spines have their component rods very abruptly expanded at the tip; the margin of this expanded part is usually entire, but may be finely or coarsely serrate. All three kinds of pedicellariae are present, but they are very small; the largest tridentate have valves only .10–.12 mm. The valves of the triphyllous have coarsely dentate margins, as in *rubra* (Pl. 124, fig. *20*) but the "teeth" are longer.

The Albatross took *pellucida* twice during its trip to Japan in 1900 and once during its much more extended visit in 1906. The specimens range from 20 to 45 mm. in length.

Station 3708. Off Ose Zaki, Honshu, Japan. Bott. temp. ? 60–70 fms. Gn. m., vol. s., a.

Station 3713. Off Ose Zaki, Honshu, Japan. Bott. temp. ? 45–48. fms. Vol. s., sh., r.

Station 4885. Between Nagasaki and Kagoshima, Japan. Bott. temp. 61.7°. 53 fms. Dk. gy. s., brk. sh.

Bathymetrical range, 45–70 fms.

Twelve specimens.

Peronella rubra.

Peronella (Laganum) rubra Döderlein, 1885. Arch. f. Naturg., **51**, 1, p. 106.

Plates 124, figs. *18–20;* 142, figs. *5–7.*

The miliary spines are like those of *pellucida;* the component rods (Pl. 124, figs. *18, 19*) being abruptly expanded at the tip. The pedicellariae are all small and are best designated as triphyllous; the blades are coarsely dentate (Pl. 124, fig. 20) and are only .04–.08 mm. long. No tridentate or ophicephalous pedicellariae could be found. The ALBATROSS did not take this species. The specimens figured are in the M. C. Z. collection.

Peronella minuta, comb. nov.

Laganum minutum de Meijere, 1904. SIBOGA Ech., p. 125.

I have not seen this species which is known only from the Sulu Archipelago.

Peronella analis, comb. nov.

Laganum anale de Meijere, 1904. SIBOGA Ech., p. 129.

Having one of the SIBOGA specimens at hand, I can confirm de Meijere's observations. I also found triphyllous pedicellariae. This species was taken by the Siboga at three widely separated stations in the Dutch East Indies.

Peronella peronii.

Laganum peronii Agassiz, 1841. Mon. Scut., p. 123.
Laganum (Peronella) peronii Gray, 1855. Cat. Rec. Ech. Irreg., p. 13.

Plate 124, figs. *21, 22.*

As this is the type of the genus and was not studied by de Meijere, a few notes may be given here. The component rods of the miliary spines are abruptly expanded and the terminal margin is rather finely serrate. Aside from some ophicephalous pedicellariae, the valves of which have broad and very blunt

blades (Pl. 124, fig. *21*), the only ones found may be called either small tridentate or triphyllous. Their valves (Pl. 124, fig. *22*) have the blades very broad and the margins very coarsely dentate. As these valves are scarcely .10 mm. in length, I have preferred to call them triphyllous. Australia and Tasmania are the home of this interesting species.

FIBULARIIDAE Gray.

It is of course difficult to determine whether the simple nature of the petals and madreporite in the members of this family are primitive characters retained or secondary simplifications. From the geological point of view, this group ought to be the ancestral stock from which the other clypeastroids have been derived, it is known from so much earlier strata than any of the others. But if we disregard this single fact, it becomes evident that nothing in the structure of the Fibulariidae requires us to consider them as primitive, while many details suggest that they are highly specialized. Thus there can be no question that the condition of the auricles and the arrangement of the aboral interambulacral plates are both specialized, and it seems equally clear that the structure of the miliary spines is of the same nature. These three characteristic features ally the family very closely with the Laganidae, while the two characters which separate the two families, the condition of the petals and madreporite, cannot be positively placed as either primitive or derived. Hawkins (1912, Geol. Mag., new ser. dec. 5, 9, p. 297) has recently described a Fibularia from southern Nigeria, which is very interesting in considering this matter, for it has well-differentiated petals and numerous madreporic pores. Unfortunately Mr. Hawkins has not been able to determine the condition of the auricles. The geological horizon of this species is "probably Lower or Middle Eocene." It is possible to interpret this as one of the early, primitive species of the family from which our modern Fibulariidae have been derived by the reduction of the petals and loss of all madreporic pores but one. Except for the shape of the test and the unusually divergent poriferous areas, *Fibularia nigeriae* is just as much one of the Laganidae as it is one of the Fibulariidae. It seems therefore that the discovery of *F. nigeriae* strengthens the belief that the Fibulariidae are a modern, highly specialized family nearly related to the Laganidae, and probably derived from the same stock.

The family contains only two genera and these are not to be distinguished

from each other by any external characters. Yet the internal structure of the test is so different in the two genera and this difference is so constant, that I have been forced to adopt as the distinguishing character the presence or absence of internal radiating partitions. Comparison of figures *3* and *7* on Plate 126 will make this difference more clear than an elaborate description. The partitions in Echinocyamus do not always extend the whole length of the radius but may run inward only a short distance from the margin (Pl. 127, fig. *3*). In Fibularia, however, there is generally no indication of such partitions except in the posterior part of the test. Externally the two genera are strikingly similar, especially when covered with their spines, but as a rule the species of Echinocyamus are flat and broad while in Fibularia, the vertical diameter is usually more considerable. Echinocyamus is world-wide in its distribution although it is not yet known from the west coast of America, but Fibularia is confined chiefly to the East Indian region, ranging from Japan to Australia; specimens are also known however from the Red Sea.

Key to the Genera of Fibulariidae.

Test more or less elevated, without internal radiating walls, except posteriorly where they are usually indicated . . . . . *Fibularia.*

Test more or less flattened with internal radiating walls bounding the ambulacra . . *Echinocyamus*

Fibularia.

Lamarck, 1816. Anim. sans Vert., **3**, p. 16.

Type, *Fibularia trigona* Lamarck, *loc. cit.* = *Echinocyamus craniolaris* Leske, 1778. Add. ad Klein, p. 150.

The species of this genus are known almost wholly from the bare tests. Excepting the Australian species *nutriens*, I have seen no specimens clothed in spines. The Siboga collected three species in the Dutch East Indies, but apparently of only one were there specimens with spines and pedicellariae. Our knowledge of these external structures is therefore quite deficient but enough is known to satisfy us that in neither spines nor pedicellariae does the genus differ essentially from Echinocyamus. The Albatross has not collected any examples of Fibularia, the specimens from the Hawaiian Islands referred to *F. australis* in the preliminary report (Bull. M. C. Z., **50**, p. 247) proving to be Echinocyamus. More than twenty-five species of Fibularia have been named but the great majority of them were based on specimens of Echinocyamus, on young clypeastroids of other genera, or on individual variants of *F. craniolaris*. All told there seem to be six valid species in the genus, so far as present knowledge

goes. Possibly even this is too large a number, for there is no doubt of the great variability in form shown by *craniolaris* and *volva* and very likely there is equal variability in the development of the petals and the size of the pores. Moreover material is scanty and further accumulations may prove the basis for very different conclusions.

Key to the Species of Fibularia.

Petals present, more or less well formed; no obvious sexual dimorphism.
- Pores of petals small, usually much smaller than genital pores.
  - Anus large nearly or quite equalling mouth; test flattened, v.d. about .40 test length; petals well developed with 8–24 pore-pairs on each side . . . . . *australis.*
  - Anus very small, not half as large as mouth.
    - Test high (v.d. often .80 test-length), broad (.80–.90 t.–l.), more or less egg-shaped . . . . . *craniolaris.*
    - Test low (v.d. about .40 t.–l.) and not very broad (about .80 t. l.) . . . . *acuta*
- Pores of petals few and large, usually bigger than genital pores; anus scarcely half as large as mouth or even smaller.
  - Petals rather short but with from 40 to 120 pores in all five together; test about half as high as long . . . . . *volva.*
  - Petals ill defined, covering most of abactinal surface, with only 30–36 large pores; test about two fifths as high as long . . . . . *cribellum.*

Petals wanting; dorsal surface of female with conspicuous depressed brood-pouch . . . *nutriens.*

Fibularia australis.

Desmoulins, 1837. Études sur les Ech. Tab. Syn., p. 240.

This is the largest species of the family, reaching a length of nearly 20 mm. There are specimens in the M. C. Z. collection from the Hawaiian, Gilbert, and Kermadec Islands, but these are all small. The large specimen, figured in the Revision, was purchased in Hamburg and the original locality is not known.

Fibularia craniolaris.

Echinocyamus craniolaris Leske, 1778. Add. ad Klein, p. 150.

Fibularia craniolaris de Blainville (not de France, as stated in the Revision, p. 129), 1820. Dict. Sci. Nat., **16**, p. 512.

Echinus ovulum Gmelin, 1788. Linné. Syst. Nat., ed. 13, p. 3194. (*Fibularia ovulum* Lamarck, Agassiz, Gray, A. Agassiz, *et al.*).

I have not been able to find any good reason why *ovulum* should take precedence over *craniolaris* as the correct name for this species, as the latter was used in connection with a description and figure, which are as recognizable as could be expected at that date, ten years earlier.

Fibularia acuta.

Yoshiwara, 1898. Ann. Zool. Japon., **2**, p. 60.

Plate 126, figs. *1–4*.

Through the great courtesy of Dr. Goto in sending me one of Yoshiwara's type specimens, I am able to supplement his description with figures. There seems to be no doubt of the distinctness of this species, for the shape of the test is quite unlike that of any of the numerous forms of *craniolaris*. The specimen figured was taken at Asamiwan, Tsu-shima, in Korea Strait.

Fibularia volva.

Agassiz and Desor, 1847. Ann. Sci. Nat., ser. 3, **7**, p. 142.

This species has the widest known range of any member of the genus. There are specimens in the M. C. Z. collection from the Red Sea, Japan, the Kei Islands, and Torres Strait.

Fibularia cribellum.

De Meijere, 1903. Tijdschr. Nederland Dierk. Ver., ser. 2, **8**, p. 7.

The SIBOGA took six specimens of this species at six very widely separated points in the Dutch East Indies, but apparently they were all bare tests for de Meijere makes no reference to either spines or pedicellariae.

Fibularia nutriens.

H. L. Clark, 1909. Mem. Austr. Mus., **4**, p. 557.

This, the smallest known species of echinoid, has been recorded only from the coast of New South Wales. In the original description I recorded it as the only clypeastroid known in which the test of the female was modified for the purpose of caring for the young. Dr. F. A. Bather promptly called my attention to a paper by Dr. T. S. Hall On the occurrence of a marsupium in an echinoid belonging to the genus Scutellina, (1908, Proc. Roy. Soc. Victoria, new ser., **20**, p. 140–142). The marsupium in Scutellina is on the oral surface anterior to the mouth and hence very different from the one in *F. nutriens*.

Echinocyamus.

Leske, 1778. Add. ad Klein, p. 149.

Type, *Echinocyamus angulosus* Leske, *op. cit.*, p. 151 = *Echinus minutus* Pallas, 1774. Spic. Zool., 10, p. 34, pl. 1, fig. 25.

Although Mr. Agassiz, in the Revision, only recognized one species in this genus, the later work of Mazetti, de Meijere, and Mortensen has shown that the genus really contains a considerable group of more or less distinct species. In studying the large series of specimens in the M. C. Z. collections, I discovered two very distinct, undescribed species, and careful examination of the Hawaiian Fibulariidae collected by the ALBATROSS has forced me to the conclusion that that small series includes two new forms. I therefore recognize at the present time eleven species, but admit freely that three or four of these are difficult to differentiate clearly and possibly are not valid. I have examined specimens of nine species but have not seen either *elegans* or *macrostomus;* the latter seems to be perfectly distinct, but *elegans* is dubious to say the least. All of the species are small, specimens exceeding 10 mm. in length being quite unusual although Mortensen records one 15 mm. long. The bathymetrical range of the species is nearly as remarkable as their wide geographical distribution for while they are chiefly confined to shallow water, at least one species occurs at from 800–1,270 fms.

Key to the Species of Echinocyamus.

Petals well formed with six or more pore-pairs on each side.
- Poriferous areas slightly curved and converging, at least in posterior pair of petals; test closely covered with minute tubercles; primaries scattered and smaller than genital pores; test not concave orally but a little depressed back of mouth; ocular pores smaller than genital . . . . . *provectus.*
- Poriferous areas straight, parallel on diverging; test covered with coarser tubercles; primaries larger than genital pores.
  - Petals very conspicuous reaching nearly to margin (except posteriorly); poriferous areas widely divergent with ten to fifteen pore-pairs in each; periproct nearer mouth than margin; test rather high, flat above, somewhat concave beneath; mouth longer than wide . . . . . *megapetalus.*
  - Petals less conspicuous; poriferous areas parallel or slightly diverging, usually with fewer than ten pore-pairs in each.
    - Test flattened; apical system anterior to center.
      - Test wide, its breadth rarely less than .80 of length; flat or slightly concave orally . . . . . *minutus.*
      - Test long and narrow, its breadth only about .70 of length; markedly concave orally, at least posterior to mouth . . . . . *elongatus*

Test more or less arched above; apical system at center; markedly concave below; mouth pentagonal.
Poriferous areas slightly depressed with intervening parts of test usually elevated; interambulacra often form more or less evident keel-like ridges proximally; pore-pairs in specimen about 7 mm. long, six to seven on each side . . . . . *crispus.*
Poriferous areas flush with surface of evenly arched test; pore-pairs more numerous, about nine on each side of petal in specimen 5.5 mm. long . . . . . *elegans.*
Petals more or less imperfect with one to five (rarely six) pore-pairs on each side.
Glassy tubercles of test conspicuously high, numerous, rounded or bluntly pointed, making surface of test very rough; test broad and flat; ocular pores smaller than genitals, though the difference may be very slight . . . . . *scaber.*
Glassy tubercles low, rounded and often few in number.
Ocular pores nearly or quite as big as genitals . . . . . *grandiporus.*
Ocular pores much smaller than genitals.
Test exceedingly flat, v. d. less (often much less) than .25 of test-length; periproct near margin, distant from mouth twice its own diameter or more . . . . . *platytatus.*
Test not so flat; periproct more or less nearly midway between mouth and margin.
Unpaired petal with about four pore-pairs on each side; diameter of mouth about twice that of periproct . . . . . *incertus.*
Unpaired petal with only one or two pore-pairs on each side; diameter of mouth about three times that of periproct . . . . . *macrostomus.*

Echinocyamus provectus.

De Meijere, 1903. Tijdschr. Nederland Dierk. Ver. ser. 2, **8**, p. 6.

This species is known from four stations in the Dutch East Indies, in 50–200 fms. and from the coast of New South Wales in 40–60 fms.

Echinocyamus megapetalus,[1] sp. nov.

Plate 126, figs. *5–8.*

Length, 7 mm.; breadth, 5 mm.; height, 2.8 mm.; mouth, 1.5 × 1 mm.; periproct not quite 1 mm. in diameter. Test high, but flattened aborally and somewhat concave beneath. Apical system at center. Petals very distinct and large; poriferous areas widely divergent, each with ten to fifteen pairs of pores. Periproct nearer to mouth than to margin. Genital pores larger than ocular pores. Radiating partitions within test very well developed (Pl. 126, fig. 7). Auricles conspicuous in interambulacra. Ambulacra more than

[1] μέγας = big + πέταλον = petal, in allusion to the unusual size of the petals.

twice as wide as interambulacra at ambitus. Primary tubercles relatively large, evidently larger than genital pores. Glassy tubercles rounded and inconspicuous. Madreporic pore smaller than a genital pore.

The holotype and five other specimens in the M. C. Z. collection are all from Mauritius. They are bare tests, received from Mrs. Luckock some forty years ago.

This is certainly the most distinct and easily recognized member of the family, and is not especially near any of the other species of Echinocyamus, the large and rather ornamental petals being quite distinctive. All of the specimens are white and have the appearance of being slightly water worn.

Echinocyamus minutus.

Echinus minutus Pallas, 1774. Spic. Zool., **10**, p. 34.
Echinocyamus minutus de Blainville, 1834. Man. Act., p. 214.

When Pallas's description of his *Echinus minutus* is carefully examined in connection with his fig. 25, pl. 1, and due consideration is given to his remarks about habitat and occurrence, it is almost impossible to doubt that his name was given to the fibulariid which O. F. Müller two years later called *Spatagus pusillus*. Although *Echinocyamus pusillus* is the name used in the Revision and other later publications, I am therefore obliged to replace it with *Echinocyamus minutus* (Pallas).

Echinocyamus elongatus,[1] sp. nov.

Plate 126, figs. *9–11*.

Length, 9 mm.; breadth, 6 mm.; height, 2.6 mm.; mouth about 1.5 mm. across and periproct about .8 mm. Test long, low, flat and rather narrow for a fibulariid. Apical system decidedly anterior to center. Mouth somewhat sunken and test posterior to it decidedly concave. Petals distinct and well formed but rather short. Poriferous areas nearly parallel, each with about ten pairs of pores. Periproct about midway between mouth and margin. Genital pores larger than ocular pores. Radiating partitions within test fairly well developed. Auricles rather low, but wide. Ambulacra scarcely twice as wide as interambulacra at ambitus. Horizontal series of ambulacral pores distal to petals, conspicuous. Primary tubercles large, larger than genital pores.

[1] *elongatus* = lengthened, in reference to the form of the test.

Glassy tubercles insignificant. Madreporic pore smaller than a genital pore. Color of bare test, pale brown.

The holotype is from Station 3846.

Although rather closely allied to *E. minutus* of Europe, this species is easily distinguished by its narrow test. Several of the specimens from Hawaii, which I refer to this species, are very young. One of these, a bare test, shows considerable resemblance to *E. megapetalus*, as the apical system is nearly central. Two other specimens are clothed in their natural coat of spines; the color is pale yellowish brown; the primaries are about twice as long as the miliaries and neither are peculiar; no pedicellariae were found. There are two bare tests of this species, from Guam, in the M. C. Z. collection.

The Hawaiian specimens were taken at the following places:—

Station 3846. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands. Bott. temp. 71.5°. 60–64 fms. Crs. br. s, sh., gr.

Station 4064. Off Kauhola Light, Hawaii, H. I. Bott. temp. 69°. 63–107 fms. Vol. s., for., co.

Station 4148. Off Modu Manu, H. I. Bott. temp. 77.9°. 26–33 fms. Co. s., for.

Bathymetrical range, 26–107 fms. Extremes of temperature, 77.9°–69°. Six specimens.

Echinocyamus crispus.

Mazetti, 1895. Mem. Reg. Accad. Sci. Modena, ser. 2, **10**, p. 215.

Although originally described from the Red Sea, this species seems to be common in the East Indies, where the Siboga took it at many stations.

Echinocyamus elegans.

Mazetti, 1895. Mem. Reg. Accad. Sci. Modena, ser. 2, **10**, p. 216.

This is another Red Sea species, but it has not yet been taken elsewhere and its validity as a good species is open to considerable question.

Echinocyamus scaber.

De Meijere, 1903. Tijdsch. Nederland Dierk. Ver., ser. 2, **8**, p. 5.

I have nothing to add to de Meijere's full account of this species given in his report on the Siboga Echini (1904). The Hawaiian specimens agree very

well with his description and figures. The depth at which this species lives is worthy of remark. The Albatross specimens were taken at the following places:—

Station 3839. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands. Bott. temp. 46.3°. 259–266 fms. Lt. br. m., s.

Station 3908. Off Diamond Head, Oahu, H. I. Bott. temp. 43.8°. 304–308 fms. Fne. wh. s., m.

Station 3914. Off Diamond Head, Oahu, H. I. Bott. temp. 46° (?). 289–292 fms. Gy. s., m.

Bathymetrical range 259–308 fms. Extremes of temperature, 46.3°–43.8°. Five specimens, of which four are bare tests.

Echinocyamus grandiporus.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 33.

Dr. Mortensen's presentation of the claims of this species is quite convincing. There are specimens in the M. C. Z. from numerous stations in the West Indian region, extending from the Florida Keys, western Cuba, and Yucatan Bank, through the Leeward Islands and southward to Bahia, Brazil. The bathymetrical range is from 79 to 805 fms. There are no specimens of any other fibulariid from the West Indian region in the M. C. Z. collection.

Echinocyamus platytatus,[1] sp. nov.

Plate 127, figs. *1–6*.

Length 6 mm.; breadth, 5.5 mm.; height 1.4 mm., mouth about 1 mm., and periproct .6 mm., across. Test very low, broad and flat, not concave orally. Petals imperfect and indistinct with only two or three pairs of pores on each side. Periproct about twice as far from mouth as from margin. Sexes easily distinguishable, as the genital pores of the female (Pl. 127, fig. *6*) are very much larger than those of the male (Pl. 127, fig. *5*). Even in the male the genital pores are larger than the ocular pores. Radiating partitions in test not well developed (Pl. 127, fig. 3), extending scarcely half way from margin to mouth. Auricles low and wide. Ambulacra hardly twice as wide as interambulacra, at ambitus. Primary tubercles relatively large, but not so large as female

[1] πλατύτατος = most flat.

genital pores. Glassy tubercles low and inconspicuous. Madreporic pore small, not as large as male genital pore.

The holotype and numerous other specimens in the M. C. Z. collection are from Port Phillip, Victoria. All are bare tests and most of them are more or less water worn.

To the kindness of my friend, Dr. T. S. Hall of Melbourne, I owe the privilege of describing this interesting new species. Several years ago he sent specimens for identification, and when informed that they seemed to represent a new species which he ought to describe, he generously sent many more specimens with the statement that he wished me to do the describing. There is no doubt that *platytatus* is quite distinct from any previously known species, and the sexual dimorphism which it shows is most interesting, especially since it is an Australian species of Fibularia which shows the only sexual dimorphism known in that genus. The specimens of *platytatus* before me range from 2.7 mm. to 8 mm. in length; the largest is 7 mm. wide and 1.8 mm. high.

Echinocyamus incertus,[1] sp. nov.

Plate 128, figs. *1–3*.

Length 6 mm.; breadth not quite 5 mm.; height not quite 2 mm., mouth about 1.2 mm. in diameter and periproct about .6 mm. Test moderately flattened, narrowed anteriorly, not at all concave beneath, though there is a very slight depression just back of the mouth. Petals evident but poorly formed and with few pore-pairs, yet anterior petal has about four pore-pairs on each side. Periproct much nearer to margin than to mouth. Genital pores much larger than oculars. Radiating partitions within test (so far as can be seen through mouth) fairly well developed. Auricles rather low and broad. Primary tubercles about equal to genital pores. Glassy tubercles apparently wanting. Madreporic pore much smaller than a genital pore.

The holotype and only specimen is from Albatross Station 4045. Off Kawaihae Light, Hawaii, Hawaiian Islands. Bott. temp., 49°. 147–198 fms. Co. s., for.

In the preliminary report on the Albatross Hawaiian Echini (1907, Bull. M. C. Z., **50**, p. 247) this specimen was listed as "*Fibularia australis*," but as more detailed study has shown that there are no Fibularias in the collection, the proper identification of this specimen has given some trouble. I have finally

[1] *incertus* = dubious, in allusion to its doubtful status.

determined to name it as a new species of Echinocyamus. It is obviously different from the two other Hawaiian species collected by the Albatross, but how much of this difference is due to individual diversity, I cannot decide. It is hard to believe, however, that an individual variant of either *elongatus* or *scaber* would show the characters of this specimen.

Echinocyamus macrostomus.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 36.

This Atlantic species is notable for its living at great depths. It is known only from stations in 800–1,270 fathoms.

SCUTELLIDAE Agassiz.

The form of the test and the condition of the auricles in the various members of this family indicate that it is a highly specialized group and this opinion is confirmed by the pedicellariae, which are rarely abundant, but are often very few in number and usually have only two valves. Nothing is known of the pedicellariae of Rotula and I regret to say no specimens of the genus, except bare tests, are in the M. C. Z. collection. Judging from the characters of the test alone, Rotula may well be considered the most highly specialized form of clypeastroid known either living or fossil. On the other hand, all the characters of Echinarachnius point to it as one of the least specialized members of the family and it is very possibly quite near the ancestral stock from which the scutellids arose. The recent genera of the family are easily distinguished from each other by very obvious external characters, the presence or absence of lunules and marginal slits being the most important. When lunules are present, their position and number furnish good, constant characters, but the size is often very variable, especially in Encope. The latter genus is further remarkable for being the only genus in the family which has retained five genital pores. The position of the periproct and of the apical system may be useful characters, and for specific differences the lengths of the different petals in relation to each other is often very important. The following key will serve to distinguish seven genera of recent scutellids.

Key to the Genera of Scutellidae.

Test without marginal slits or lunules.

Abactinal system at apex of test; petals about equal; periproct marginal . . . *Echinarachnius.*

Abactinal system posterior to apex; posterior petals much shorter than others; periproct on oral surface . . . . . *Dendraster.*

Test with marginal slits, or lunules, or both.
Not more than two marginal slits, and often none, in posterior half of test-margin.
No lunule in posterior interambulacrum.
Two lunules or marginal slits present, one in each posterior ambulacrum *Echinodiscus.*
Five lunules present, one in each ambulacrum . . . . . *Astriclypeus.*
A lunule in posterior interambulacrum.
Genital pores 5 . . . . . *Encope.*
Genital pores 4 . . . . . *Mellita.*
Eight or more marginal slits in posterior half of test-margin . . . . . *Rotula.*

Echinarachnius.

Gray, 1825. Ann. Phil., **26**, p. 428.

Type, *Scutella parma* Lamarck, 1816. Anim. sans Vert., **3**, p. 11.

Although this genus is easily recognized, specific limits within it are very perplexing and have been the source of some confusion and probably of no little error with reference to the geographical distribution of the different forms. The Northern Pacific Ocean, particularly the vicinity of Kamtchatka and Japan seem to be the center of distribution for the genus. All three of the species here recognized as valid occur there and two of them are not known from elsewhere. The extraordinary range ordinarily attributed to *E. parma* requires a reinvestigation. The records from the Red Sea, Mauritius, Indian Ocean, and Australia are almost certainly erroneous and there is no reason to believe that the genus occurs south of 32° N. in either the Atlantic or Pacific Oceans. The only characters which are available for distinguishing species are the shape of the petals, the height and solidity of the test, the manner of branching of the actinal ambulacral furrows, and the color. The last may be a very constant and valuable character for all we know to the contrary but unfortunately the red-brown pigment of clypeastroids (or at least of many of them) becomes transformed into a beautiful green color on immersion in fresh water or alcohol, and even undergoes more or less change in drying. Museum specimens of Echinarachnius may thus show an extraordinary diversity of color, no shades of which are necessarily distinctive. The use of color therefore as a specific mark is open to serious objection, yet in some cases it is certainly helpful. The shape of the petals and of the test are hardly less uncertain characters than the color and too much stress must not be laid on any one character. The forking of the actinal ambulacral furrows is of course a much more fundamental character than any of the others, and differences shown in this feature seem to be very

constant. The pedicellariae are reduced in both number and size. All have two valves. The bidentate are remarkable for the more or less complete lack of apophyses, while the biphyllous are very small indeed and of rather an odd shape (Pl. 125, fig. 7). There are no calcareous disks or rings in the pedicels but each sucker is strengthened by a pair of calcareous rods, somewhat bent, lying with their concave sides towards each other and with an outstanding spine on the convex side. After the examination of hundreds of specimens, it has seemed desirable to recognize three species and one variety.

Key to the Species of Echinarachnius.

Actinal ambulacral furrows branching only near distal end.
- Test variable in height but not remarkably thick and solid; color in life reddish brown of some shade, often very light, becoming green in alcohol and drying green or brown often very dark; abactinal primary spines not conspicuously thickened near tip.
  - Test low and flat, v. d. .11–.18 test-length . . . . . *parma.*
  - Test high, sometimes more or less conical, v. d., .17–.25 test-length . . . *parma* var. *obesa.*
- Test high, v. d. = .18–.25 test-length, and remarkably thick and solid; color in life unknown; alcoholic and dry specimens similar, more or less strongly violet, especially on oral surface, but primary spines whitish; abactinal primary spines remarkably swollen near tip . . . . . *asiaticus.*

Actinal ambulacral furrows forking proximal to middle . . . . . *mirabilis.*

Echinarachnius parma.

Scutella parma Lamarck, 1816. Anim. sans Vert., 3, p. 11.
Echinarachnius parma Gray, 1825. Ann. Phil., **26**, p. 428.

Plate 125, figs. 7, 8.

This is the common sand-dollar of the East coast of North America, from New Jersey northward at least to Labrador. Apparently it occurs on the West coast also from Alaska as far south as Puget Sound. On the Asiatic coast it is represented by the following variety, which also occurs along the Alaskan Peninsula.

Echinarachnius parma var. obesa,[1] var. nov.

Plate 143, figs. 5–8.

Similar to *E. parma* except that the test is remarkably high, the vertical diameter often one fourth of the test-length. Extreme examples are so unlike the ordinary *parma*, one is tempted to consider them a distinct species and Mr.

[1] *obesus* = fat, in allusion to the plump test.

Agassiz (1872, Rev. Ech., p. 108, 316, 317) supposed that it was such a specimen on which Michelin founded his species *asiaticus*. Consequently Mr. Agassiz considered *asiaticus* a synonym of *parma* whereas it is really quite a different species. There are in the M. C. Z. collection specimens of *parma* from off the eastern United States which are a trifle higher than the lowest *obesa* from Kamtchatka and are not otherwise certainly distinguishable, so that *obesa* is clearly not a valid species or even a subspecies, but may conveniently be recognized as a variety. The pedicellariae are not distinguishable from those of typical *parma*. The bidentate have valves (Pl. 125, fig. *8*) .30–.40 mm. long, entirely lacking apophyses and with the tip somewhat serrate, under high power. The biphyllous (Pl. 125, fig. *7*) have valves only about .04 mm. long, and somewhat hood-shaped. No ophicephalous pedicellariae were found.

The Albatross brought back *obesa* from the following points:—

Station 4283. Off Tuliumnit Point, Chignik Bay, Alaska. 30–41 fms. Bk. s., br. sp.

Station 4786. Off Copper Island, Komandorskis. 54 fms. Gn. s.

Station 4787. Off Copper Island, Komandorskis. 54–57 fms. Gn. s.

Station 4794. Off Staritschkof Island, Kamtchatka. 58–69 fms. S., p.

Station 4795. Off Staritschkof Island, Kamtchatka. 48–69 fms. Gn. s., p.

Station 4796. Off Staritschkof Island, Kamtchatka. 48 fms. S., p., sh.

Bathymetrical range, 30–69 fms.

Sixty-seven specimens.

Echinarachnius asiaticus.

Michelin, 1859. Rev. et Mag. Zool., **2**, no. 9, p. 3.

Plate 143, figs. *1–4*.

There is hardly room for questioning the distinctness of this species but it is possible that it is not entitled to Michelin's name. His description of the color fits fairly well, but not exactly and his specimen was not as high as might be. But on the whole, it seems much better to use Michelin's name than to introduce a new one, particularly as his specimen came from Kamtchatka. The abactinal primary spines are strikingly different from those of *parma;* they are not only much stouter but they are conspicuously swollen at the tip and their almost white color adds to their prominence. They are numerous and of nearly uniform length, giving the test a coarser, heavier, and less velvety covering than that of *parma*. The general violet cast in the coloration varies somewhat in different

specimens, the shade depending largely on how much the primary spines are tinged; where they are nearly white the general coloration is very light, almost lavendar, but where they are distinctly purplish, the general effect is of course much darker.

The only specimens of this species taken by the ALBATROSS were at Station 3781. Off Cape Nalacheff, Kamtchatka. 39–42 fms. Gy. s., g. Five specimens.

Echinarachnius mirabilis.

Scaphechinus mirabilis A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 359.
Echinarachnius mirabilis A. Agassiz, 1872. Rev. Ech. pt. 1, p. 107.
Echinarachnius pacificus Pfeffer, 1881. Verh. Naturw. Ver. Hamburg-Altona im 1880, p. 65.
Echinarachnius tenuis Yoshiwara, 1898. Ann. Zool. Jap., **2**, p. 61.

Plate 125, fig. *6*.

The deep violet color, added to the very characteristic branching of the actinal ambulacral furrows, serve to make this species very easy to recognize, yet both Pfeffer and Yoshiwara have described *mirabilis* under other names. In the case of Yoshiwara however, there is considerable excuse, for he had only young specimens and their very delicate, flat tests, almost white in color, are at first glance very different from those of *mirabilis*. Thanks to Dr. Goto, I have examined Yoshiwara's types and am thus able to state that they are the young of *mirabilis*.

The bidentate pedicellariae of this species are noticeably different from those of *parma*. The valves (Pl. 125, fig. *6*) have straighter sides and more coarsely dentate tips, while there is also a more or less developed apophysis — not one which can be of much functional importance but still more than is to be found in the valves of *parma*.

Although this is one of the characteristic echinoderms of Japan, it was not taken by the ALBATROSS on either of her visits.

Dendraster.

Agassiz and Desor, 1847. Ann. Sci. Nat., ser. 3, **7**, p. 135.
Type, *Scutella excentrica* Eschscholtz, 1831. Zool. Atlas, **4**, p. 19.

It is, of course, merely a matter of opinion whether the peculiarities of "*Scutella excentrica*" entitle it to generic separation from Scutella and Echinarachnius. In my judgment however they do and I have accordingly accepted

Agassiz's and Desor's genus. So far as spines and pedicellariae go, Dendraster is not to be distinguished from Echinarachnius, yet the primary spines have a characteristic form, the tip (Pl. 125, figs. *4*, *5*) being somewhat swollen and then abruptly flattened and pointed. Pedicellariae seem to be very scarce and small; the bidentate have rather more of an apophysis than those of *Echinarachnius parma* but less than those of *E. mirabilis*. The genus contains but one species.

Dendraster excentricus.

Scutella excentrica Eschscholtz, 1831. Zool. Atlas, **4**, p. 19.
Dendraster excentricus Agassiz and Desor, 1847. Ann. Sci. Nat., ser. 3, **7**, p. 135.

This sand-dollar, characteristic of the Pacific coast of North America from Lower California to Alaska, was collected by the ALBATROSS at the following points:—

Union Bay, Bayne Sound, British Columbia.

Station 2835. Off Lower California, 26° 42′ 30″ N., 113° 34′ 15″ W., 5.5 fms. Gn. m.

Twenty-six specimens.

Echinodiscus.

Leske, 1778. Add. ad Klein, p. 131.
Type, *Echinodiscus bisperforatus*, Leske, 1778. Add. ad Klein, p. 132.

This genus is notable as the only one among the Scutellidae which has retained ophicephalous pedicellariae; at least, it is the only genus in which I have found them. They have three valves, as in all other Echini where they are known, and show no special peculiarities; the blade (Pl. 125, fig. *12*) is well rounded and quite spiny. The tridentate pedicellariae show some differences which will be mentioned under the different species. Primary spines with swollen and asymmetrical tips. The disks of the pedicels contain calcareous rods, with rounded knobs on the convex side; as in Echinarachnius, these rods lie, two in each sucker, with their concave sides towards each other.

Key to the Species of Echinodiscus.

Posterior ambulacra each with a deep, narrow, marginal slit, the depth of which may equal or even exceed the length of the unpaired petal . . . . . *auritus.*
Posterior ambulacra each with a lunule distal to petal.
Antero-lateral petals little if any longer than posterior; length of test usually exceeds its width; lunules short . . . . . *tenuissimus.*

Antero-lateral petals distinctly longer than posterior; width of test exceeds its length.
Lunules longer than longest petal . . . . . *bisperforatus.*
Lunules shorter than shortest petal . . . . . *bisperforatus* var. *truncatus.*

Echinodiscus auritus.

Leske, 1778. Add. ad Klein, p. 138.

Plate 125, figs. *9*, *10*.

The biphyllous pedicellariae have broad valves (Pl. 125, fig. *9*) with rather flat blades, coarsely serrate on the margin. The bidentate are even more characteristic having the blade narrowed at base, while the basal part of the valve has the sides nearly parallel (Pl. 125, fig. *10*). The biphyllous valves are .07–.09 mm. long, the bidentate .10–.50 mm. No ophicephalous pedicellariae were seen.

The distribution of *auritus* seems to be chiefly in the western part of the Indian Ocean and in the Red Sea, but it is also known from several localities in the Dutch East Indies.

Echinodiscus tenuissimus.

Lobophora tenuissima Agassiz and Desor, 1847. Ann. Sci. Nat., ser. 3, **7**, p. 136.
Echinodiscus tenuissimus Gray, 1855. Cat. Rec. Ech., pt. 1, p. 20.
Echinodiscus laevis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 113. (From Klein, 1734).

Plate 125, figs. *11*, *12*.

All three kinds of pedicellariae occur. The ophicephalous have valves (Pl. 125, fig. *12*) only .10–.13 mm. long, exclusive of the loop which in the largest valve adds .07–.08 mm. more. The biphyllous valves are only .05–.06 mm. long. The bidentate valves (Pl. 125, fig. *11*) are .35–.40 mm. long; the blade is narrow with parallel sides while the basal part has sloping or oblique sides.

The distribution of *tenuissimus* is in the East Indian region from Japan southward to New Guinea.

Echinodiscus bisperforatus.

Leske, 1778. Add. ad Klein, p. 132.

Pedicellariae are very rare and only tridentate were found; their valves resemble those of *tenuissimus* (Pl. 125, fig. *11*). The distribution of this species seems to coincide with that of *auritus*.

Echinodiscus bisperforatus var. truncatus.

Lobophora truncata Agassiz, 1841. Mon. Scut., p. 66.

Although those who have examined the most specimens agree that this Echinodiscus is not a distinct species, the specimens I have seen are so very sharply separated from any other member of the genus, it seems to me desirable that they should at least bear a varietal name. Possibly this is the form Lamarck called *Scutella bifora* and in that case, his name might be used, but a variety "*bifora*" of a species "*bisperforatus*" seems absurd.

Astriclypeus.

Verrill, 1867. Trans. Conn. Acad., **1**, p. 311.

Type, *Astriclypeus manni* Verrill, 1867. *Loc. cit.*

This genus is characteristic of Japan and is not known from elsewhere. Tridentate and triphyllous pedicellariae, but no ophicephalous, were found. The spines are solid and only slightly swollen at the tip. The pedicels seem to lack calcareous particles of any kind.

Astriclypeus manni.

Verrill, 1867. Trans. Conn. Acad., **1**, p. 311.

Plate 125, figs. *13–15*.

The valves of the triphyllous pedicellariae (Pl. 125, fig. *15*) are quite flat with broadly rounded blades, with smooth margins. The tridentate valves vary much in size, ranging from .16 to .43 of a millimeter in length; the tips are coarsely dentate (Pl. 125, fig. *14*) and in small ones, there is often a single conspicuous tooth (Pl. 125, fig. *13*) at the tip. It is rather odd that the Albatross failed to collect this species on either of her Japanese expeditions.

Encope.

Agassiz, 1841. Mon. Scut., p. 45.

Type, *Echinodiscus emarginatus* Leske, 1778. Add. ad Klein, p. 136.

Although in his great monograph of the scutellids, Agassiz recognized nearly a dozen species of Encope, and although several more were described in the succeeding thirty years, in the Revision Mr. Agassiz reduced them all to five valid species. The genus is exclusively American and the large amount of

material Mr. Agassiz has accumulated in the M. C. Z. collection from both sides of tropical America, shows well the variability in form of both test and lunules which characterizes some of the species. Nevertheless other species, particularly *grandis*, show very little diversity and we ought to recognize six species, since one of the forms, named *perspectiva* by Agassiz in 1841, and considered in the Revision as a form of *micropora*, seems quite distinct. The solidity of the test, the position of its apex, the position of the lunules, and the length of the petals furnish the best characters for separating the species. The size of the lunules may also be of use but in some cases, especially in *emarginata*, it is most unreliable.

The spines show no noteworthy peculiarities. The pedicellariae are all bivalved and small. It is difficult to draw any line between bidentate and biphyllous forms, for the two extremes intergrade so completely. The form of the blade differs somewhat in the different species, as will be noted below, but it is doubtful if these differences are perfectly constant. The disks of the tube-feet have rods in them much as in Echinarachnius.

Key to the Species of Encope.

Test moderately heavy with margins rarely exceeding 3 mm. in thickness, and usually much less.
- Test as high anterior to abactinal system as it is posteriorly and often distinctly higher.
  - Test elevated equally both anterior and posterior to abactinal system; interambulacral lunule large, variable in form, its length, .16–.35 test-length . *emarginata.*
  - Test distinctly highest anteriorly; interambulacral lunule variable in form, small, its length only .10–.17 test-length.
    - Anterior end of interambulacral lunule nearer distal end of posterior petals than to center of abactinal system . . . . . *micropora.*
    - Anterior end of interambulacral lunule nearer to center of abactinal system than to distal end of posterior petals . . . . . *perspectiva.*
- Test highest back of abactinal system, at anterior end of interambulacral lunule.
  - Ambulacral marginal slits rarely, if ever, closed to form lunules, often reduced in the anterior ambulacra to mere notches or even entirely wanting there; petaloid area large; posterior petals about .33 test-length and unpaired petal nearly or quite as long . . . . . *michelini.*
  - Ambulacra with completely closed, rounded lunules; petaloid area moderate, none of the petals, much exceeding .25 test-length . . . . . *californica.*

Test very heavy, about as wide as long; margin about 5 mm. thick; interambulacral lunules big and round; marginal notches wide, not very deep, rarely, if ever, closed to form lunules; posterior petals .35–.40 test-length; unpaired petal about .66 posterior . *grandis.*

Encope emarginata.

Echinodiscus emarginata Leske, 1778. Add. ad Klein, p. 136.
Encope emarginata Agassiz, 1841. Mon. Scut., p. 47.

Plate 125, fig. *25*.

The bidentate pedicellariae of this species are quite characteristic; the valves have several terminal teeth at tip of blade (Pl. 125, fig. *25*) and the blade itself is rather short. The range of *emarginata* is from Uruguay northward, certainly to Venezuela and probably to Yucatan. It has also been reported from Martinique, Florida, and South Carolina but these records are open to considerable doubt. The diversity in the size and form of the lunules, particularly the posterior interambulacral, is really very extraordinary.

Encope micropora.

Agassiz, 1841. Mon. Scut., p. 50.

There is no doubt that *Encope stokesii* Agass. (= *Mellita stokesii* of the Revision) is the young of this species, whose range is from Lower California to Peru and the Galapagos. The bidentate pedicellariae have valves provided with a relatively long terminal tooth which is flanked on either side by two or three teeth not much shorter. The ALBATROSS collection contains specimens of *micropora* from two places.

James Island, Galapagos.

Station 2835. Off Lower California, 26° 42′ 30″ N., 113° 34′ 15″ W. 5.5 fms. Gn. m.

Five specimens.

Encope perspectiva.

Agassiz, 1841. Mon. Scut., p. 51.

The pedicellariae of this species are indistinguishable from those of *micropora*. Its geographical range is more northerly, from Lower California southward only to Costa Rica. There is little doubt that *Encope pacifica* Pfeffer, 1881, is identical with *perspectiva*. The only specimen of this species in the ALBATROSS collection is from Ballenas Bay, Lower California. It is a bare test and shows a curious departure from normal in that the right posterior petal terminates abruptly, *proximally*, 8 mm. from the madreporite. Its distal termination is 28 mm. from the madreporite, so this fragment of a petal is only 20 mm. long.

Accompanying this change in the ambulacra, the genital pores of interambulacra five and one have shifted their position and lie side by side, 2 mm. apart and 3 mm. from the madreporite in the region which is normally occupied by the petal. The explanation of the whole appearance is, no doubt, that for some unknown reason, ambulacrum I ceased to grow when the petal was 20 mm. long and the region which it should have filled has been built up by the adjoining interambulacra, the unusual growth of which has caused the displacement of the genital pores. It is important to note that ocular I is in position, fused to the madreporite as usual. This case falls into group 15 of Jackson's twenty combinations of character in variations from pentamerous symmetry, and agrees almost exactly with some of the cases found in regular Echini, which he studied (Jackson, 1912, Mem. Boston Soc. Nat. Hist., **7**, p. 43).

Encope michelini.

Agassiz, 1841. Mon. Scut., p. 58.

The pedicellariae of this species agree with those of *emarginata*. Its geographical range is much more limited, for it seems to be confined to the shores of the Gulf of Mexico from Cape Florida and the Florida Keys around to Yucatan.

Encope californica.

Verrill, 1871. Trans. Conn. Acad., **1**, p. 586.

The bidentate pedicellariae of this species are like those of *grandis*, the tip of the blade of each valve forming a long terminal tooth. Like *grandis* too in its distribution, *californica* seems to be confined to the Gulf of California. The ALBATROSS collection contains two specimens, one a long-dead worm-tube covered test, from

Station 2828. Gulf of California, 24° 11′ 30″ N., 109° 55′ W. 10 fms. Sh.

Encope grandis.

Agassiz, 1841. Mon. Scut., p. 57.

Plate 125, fig. *24*.

The bidentate pedicellariae have valves terminating in a conspicuous tooth (Pl. 125, fig. *24*), the margins being somewhat serrate. No other species of the genus is as easily recognized as this and no other shows so little variability. It seems to be also the least common member of the genus and appears to be confined to the Gulf of California.

Mellita.

Agassiz, 1841. Mon. Scut., p. 34.

Type, *Scutella quinquefora* Lamarck, 1816. Anim. sans Vert., **3**, p. 9 = *Echinodiscus quinquesperforatus* Leske, 1778. Add. ad Klein, p. 133.

Like the preceding this is strictly an American genus but whereas two thirds of the species of Encope occur on the *west* coast of tropical America, two of the four species of Mellita occur on the *east* coast. These clypeastroids give every indication of high specialization, not only in the extreme flatness of the test with the accompanying peculiarities of lantern and auricles, but in the lunules, the position of the periproct and even in the spines and pedicellariae. The spines are solid and the primaries are more or less swollen at the tip (Pl. 125, figs. *17*, *18*); they may be somewhat curved, while many of the miliaries are abruptly bent (Pl. 125, fig. *16*). The pedicellariae are greatly reduced in size and number and no ophicephalous are to be found. All have but two valves and these are of peculiar shape. Calcareous particles in the pedicels seem to be nearly or quite wanting; sometimes a few small rods may be present. The lunules afford the best characters for separating the species, both the number and the size and form being of real importance. There are four species which seem to be valid.

Key to the Species of Mellita.

Lunules 5.

Interambulacral lunule very variable in length but usually less than .20 test-length, and seldom much longer than posterior ambulacral lunules; if unusually long its breadth will be .15–.20 of its length . . . . . *quinquiesperforata.*

Interambulacral lunule long and very narrow, from .25 to .40 test-length and 40–100% longer than posterior ambulacral lunules; its breadth is less than .10 length . . . . . *longifissa.*

Lunules 6.

Interambulacral lunule long and narrow, its length at least twice and usually several times its own breadth . . . . . *sexiesperforata*

Interambulacral lunule broad and rounded, its length only about 25% more than its breadth . . . . . *pacifica.*

Mellita quinquiesperforata.

Echinodiscus quinquiesperforatus Leske, 1778. Add. ad. Klein, p. 133.

Mellita quinquiesperforata Meissner, 1904. Bronn's Thier-reichs, **2**, abt. 3, buch 4, p. 1384.

Plate 125, figs. *16–21*.

Pedicellariae are very scarce but the bidentate at least are quite characteristic. The valves are only .12–.18 mm. in length; they are somewhat compressed

and have a conspicuous hook or tooth, or usually two or three of them at the tip (Pl. 125, fig. *21*) but seen from within they are broad and the tip has several dentate projections; there is also a calcareous meshwork in the blade (Pl. 125, fig. *19*). The biphyllous are less distinctive; they have somewhat hood-shaped valves (Pl. 125, fig. *20*) about .07 mm. long.

This is the common "key-hole urchin" of the Florida coasts. The tests are found as far north as Nantucket and even in Vineyard Sound but the exact northern limit of the living animal is not known. It is common at Beaufort, N. C. and southward extends to Brazil.

Mellita longifissa.

Michelin, 1858. Rev. et Mag. Zool., **10**, p. 360.

Pedicellariae are very scarce but resemble those of *sexiesperforatus*. The geographical range of *longifissa* is from the Gulf of California to Panama.

Mellita sexiesperforata.

Echinodiscus sexiesperforatus Leske, 1778. Add. ad Klein, p. 135.
Mellita sexiesperforata Meissner, 1904. Bronn's Thier-reichs, **2**, abt. 3, buch 4, p. 1384.

Plate 125, figs. *22*, *23*.

The pedicellariae (Pl. 125, fig. *23*) of this species are recognizably distinct from those of *quinquiesperforata*, the most striking difference being that the valves of *quinquiesperforata* will lie flat on their backs while those of *sexiesperforata* are so compressed that they will not. The valves (Pl. 125, fig. *22*) are very small, only .10–.15 mm. long and the blade usually ends in a single sharp tooth.

This species occurs at the Bermudas and is known from Charleston, S. C. Southward it extends at least to Uruguay.

Mellita pacifica.

Verrill, 1867. Trans. Conn. Acad., **1**, p. 313.

Nothing is known of this species beyond the original description. I cannot avoid the feeling that it is an Encope and not a Mellita and is possibly identical with *E. micropora*. The type specimens were from Zorritos, Peru.

Rotula.

Agassiz, 1841. Mon. Scut., p. 23.

Type, *Rotula rumphii* Agassiz, *l. c.* = *Echinus orbiculus* Linné, 1758. Sys., Nat. ed. 10, p. 666.

Unfortunately I have been unable to examine any specimens of this genus except bare tests. One of these shows parts of the buccal membrane which seems to have been heavily plated, a most unusual condition in clypeastroids. The spines and pedicellariae will no doubt show some interesting peculiarities. The number of species in the genus is still uncertain, for while I can distinguish only the two which have long been known, Rochebrune (1881, Nouv. Arch. Mus. Paris, ser. 2, **4**, p. 328, pl. 19) figures two very different forms which he considers separate species, neither of which has lunules. Moreover none of the specimens examined have oval, nearly closed petals as in his figures, but always narrow, widely open petals with poriferous areas nearly parallel. Whether his figures err, or whether the form of the petals is very variable, or whether he is really dealing with species different from any I have seen, I am unable to decide.

Key to the Species of Rotula.

Test without lunules . . . . . *orbiculus.*
Test with a lunule in each anterior interambulacrum . . . . . *deciesdigitata.*

Rotula orbiculus.

Echinus orbiculus Linné, 1758. Sys. Nat., ed. 10, p. 666, no. 17*a*.
Rotula orbiculus Meissner, 1904. Bronn's Thier-reichs, **2**, abt. 3, buch 4, p. 1384.
Rotula rumphii Agassiz, 1841. Mon. Scut., p. 25. A. Agassiz, 1872. Rev. Ech., pt. 1, p. 155.

This species is known from Senegal and the Cape Verde Islands.

Rotula deciesdigitata, comb. nov.

Echinodiscus deciesdigitatus Leske, 1778. Add. ad Klein, p. 145.
Rotula augusti Agassiz, 1841. Mon. Scut., p. 28. A. Agassiz, 1872. Rev. Ech., pt. 1, p. 154.

This species is known only from Liberia and adjacent African coasts.

EXPLANATION OF THE PLATES.

Wherever the nature of the figure permits, the anterior ambulacrum (III) is placed uppermost.

PLATE 122.

PLATE 122.

1–4. **Clypeaster lamprus** H. L. Clark.

1. Large actinal primary spine; side view. × 6.
2. Actinal primary spine; side view. × 6.
3. Actinal primary spine; top view. × 2.
4. Tip of small primary spine; side view. × 60.

5–7. **Clypeaster rotundus** (A. Ag.).

5. Tip of primary spine; side view. × 70.
6. Tip of primary spine; top view. × 70.
7. Tip of miliary spine; side view. × 130.

8, 9. **Clypeaster leptostracon** A. Ag. & Cl.

8. Tip of miliary spine. × 150.
9. Tip of primary spine. × 70.

10. **Clypeaster audouini** Fourtau.

10. Tip of miliary spine. × 100.

11. **Clypeaster speciosus** Verrill.

11. Tip of primary spine. × 70.

12–14. **Clypeaster ravenelii** (A. Ag.).

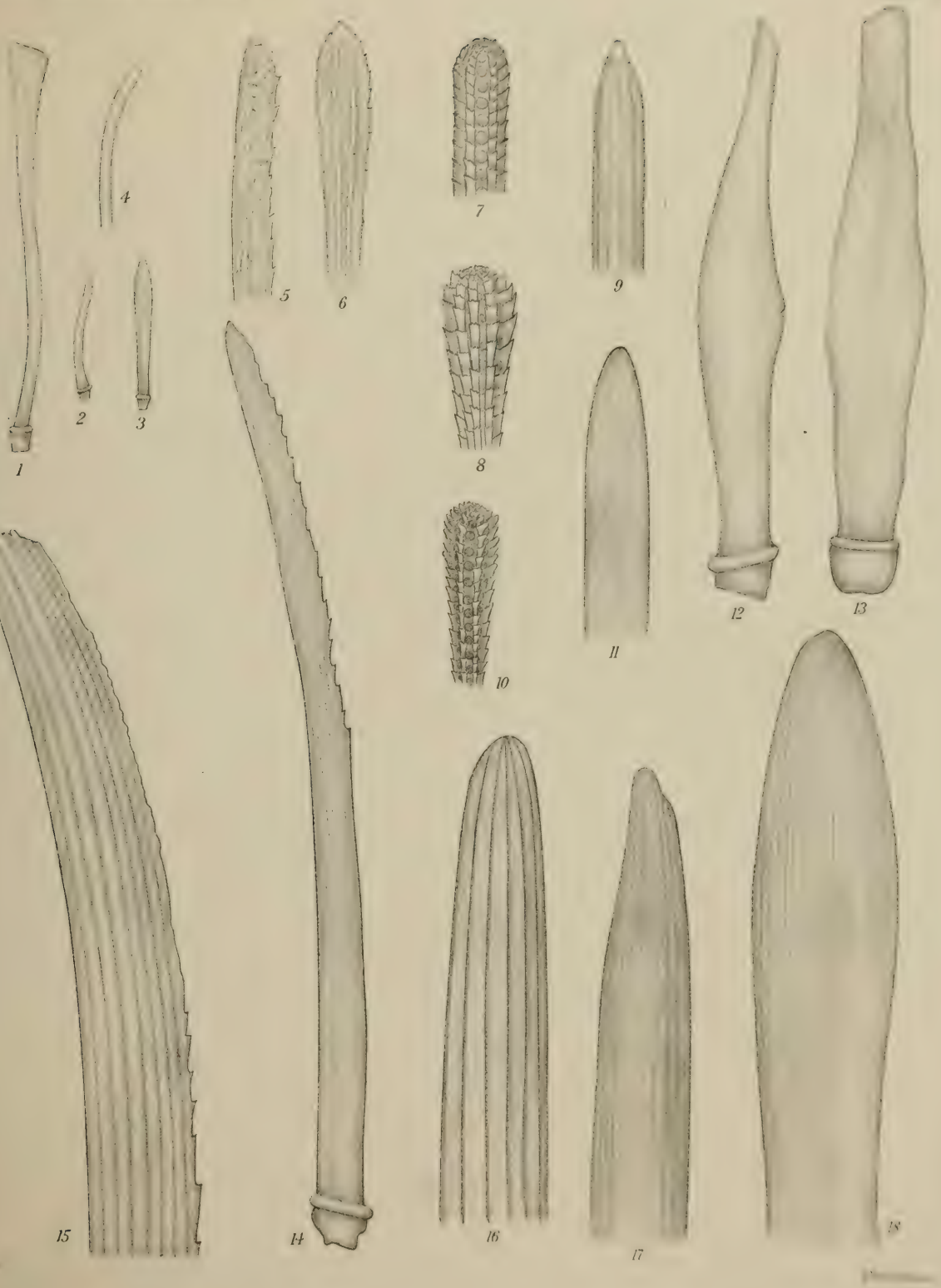
12. Actinal ambulacral primary spine, from near mouth; side view. × 30.
13. Actinal ambulacral primary spine, from near mouth; top view. × 30.
14. Actinal interambulacral primary spine; side view. × 30.

15. **Clypeaster virescens** Död.

15. Terminal third of marginal primary spine; side view. × 70.

16–18. **Clypeaster pallidus** H. L. Clark.

16. Tip of actinal primary spine; side view. × 70.
17. Tip of abactinal primary spine; side view. × 70.
18. Tip of abactinal primary spine; top view. × 70.



H.L.Clark del.

PLATE 123.

1. **Clypeaster rosaceus** (L.).

1. Tridentate pedicellaria. × 30.

2–4. **Clypeaster pallidus** H. L. Clark.

2. Side view of valve of tridentate pedicellaria. × 30.
3. Blade of valve of tridentate pedicellaria. × 70.
4. Blade of valve of ophicephalous pedicellaria. × 70.

5–10. **Clypeaster ravenelii** (A. Ag.).

5. Side view of small valve of ophicephalous pedicellaria. × 70.
6. Side view of large valve of ophicephalous pedicellaria. × 70.
7. Interior view of valve of quadridentate pedicellaria. × 70.
8. Interior view of loop of valve of ophicephalous pedicellaria. × 70.
9. Interior view of loop of valve of ophicephalous pedicellaria. × 70.
10. Quadridentate pedicellaria. × 70.

11, 12. **Clypeaster subdepressus** (Gray).

11. Quadridentate pedicellaria. × 30.
12. Interior view of valve of quadridentate pedicellaria. × 30.

13–16. **Clypeaster europacificus** H. L. Clark.

13. Small valve of ophicephalous pedicellaria. × 70.
14. Large valve of ophicephalous pedicellaria. × 70.
15. Side view of valve of tridentate pedicellaria. × 70.
16. Valve of tridentate pedicellaria. × 70.

17–20. **Clypeaster leptostracon** A. Ag. & Cl.

17. Ophicephalous pedicellaria with valves open. × 70.
18. Triphyllous pedicellaria. × 70.
19. Valve of tridentate pedicellaria. × 70.
20. Small tridentate pedicellaria. × 70.

21, 22. **Clypeaster lamprus** H. L. Clark.

21. Small tridentate pedicellaria. × 70.
22. Valve of large tridentate pedicellaria. × 70.

23. **Clypeaster humilis** (Leske).

23. Interior view of loop of large valve of ophicephalous pedicellaria. × 70.

24. **Clypeaster audouini** Fourtau.

24. Valve of triphyllous pedicellaria. × 300.

25–27. **Clypeaster rotundus** (A. Ag.).

25. Valve of triphyllous pedicellaria. × 300.
26. Side view of valve of small tridentate pedicellaria. × 300.
27. Valve of tridentate pedicellaria. × 70.

28–31. **Clypeaster virescens** Död.

28. Blade of valve of ophicephalous pedicellaria. × 70.
29. Large tridentate pedicellaria. × 70.
30. Interior view of loop of valve of ophicephalous pedicellaria. × 70.
31. Interior view of loop of large valve of ophicephalous pedicellaria. × 70.

PLATE **124.**

PLATE 124.

1, 2. **Clypeaster lytopetalus** A. Ag. & Cl.

1. Tridentate pedicellaria. × 70.
2. Valve of tridentate pedicellaria. × 70.

3–6. **Clypeaster reticulatus** (L.).

3. Valve of tridentate pedicellaria of specimen from Réunion. × 70.
4. Valve of tridentate pedicellaria of specimen from Mauritius. × 70.
5. Valve of tridentate pedicellaria of young specimen from Hawaii. × 70.
6. Valve of tridentate pedicellaria of adult specimen from Hawaii. × 70.

7–12. **Laganum depressum** Agass.

7. Valve of tridentate pedicellaria. × 70.
8. Side view of valve of tridentate pedicellaria. × 70.
9. Blade of valve of ophicephalous pedicellaria. × 350.
10. Exterior view of loop of valve *a* of ophicephalous pedicellaria. × 350.
11. Exterior view of loop of valve *b* of ophicephalous pedicellaria. × 350.
12. Exterior view of loop of valve *c* of ophicephalous pedicellaria. × 350.

13–16. **Laganum fudsiyama** Död.

13. Top of stalk of ophicephalous pedicellaria. × 350.
14. Rods of miliary spines. × 350.
15. Valve of small tridentate pedicellaria. × 70.
16. Valve of large tridentate pedicellaria. × 70.

17. **Laganum laganum** (Leske).

17. Valve of tridentate pedicellaria. × 70.

18–20. **Peronella rubra** Död.

18. Rods of a miliary spine. × 350.
19. Rod of another miliary spine. × 350.
20. Valve of a triphyllous pedicellaria. × 350.

21, 22. **Peronella peronii** (Agass.).

21. Blade of valve of ophicephalous pedicellaria. × 350.
22. Valve of triphyllous pedicellaria. × 350.

23, 24. **Peronella lesueuri** (Agass.).

23. Valve of triphyllous pedicellaria. × 350.
24. Valve of tridentate pedicellaria. × 350.

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PLATE 125.

Plate 125.

1–3. **Arachnoides placenta** (L.)

1. Bidentate pedicellaria, showing back of valve. × 70.
2. Bidentate pedicellaria, showing both valves. × 70.
3. Side view of tip of valve of bidentate pedicellaria. × 350.

4, 5. **Dendraster excentricus** (Esch.).

4. Side view of tip of primary spine. × 70.
5. Top view of tip of primary spine. × 70.

6. **Echinarachnius mirabilis** (A. Ag.).

6. Valve of bidentate pedicellaria. × 350.

7, 8. **Echinarachnius parma** (Lamarck).

7. Biphyllous pedicellaria. × 350.
8. Valve of bidentate pedicellaria. × 70.

9, 10. **Echinodiscus auritus** Leske.

9. Valve of biphyllous pedicellaria. × 350.
10. Valve of bidentate pedicellaria. × 70.

11, 12. **Echinodiscus tenuissimus** (Agass. & Des.).

11. Valve of bidentate pedicellaria. × 70.
12. Blade of valve of ophicephalous pedicellaria. × 350.

13–15. **Astriclypeus manni** Verrill.

13. Blade of valve of tridentate pedicellaria. × 350.
14. Tip of blade of valve of tridentate pedicellaria. × 350.
15. Valve of triphyllous pedicellaria. × 350.

16–21. **Mellita quinquiesperforata** (Leske).

16. Side view of miliary spine. × 350.
17. Top view of tip of primary spine. × 70.
18. Side view of tip of primary spine. × 70.
19. Valve of bidentate pedicellaria. × 350.
20. Side view of valve of biphyllous pedicellaria. × 350.
21. Side view of valve of bidentate pedicellaria. × 350.

22, 23. **Mellita sexiesperforata** (Leske).

22. Blade of valve of bidentate pedicellaria. × 350.
23. Bidentate pedicellaria. × 350.

24. **Encope grandis** Agass.

24. Side view of tip of valve of bidentate pedicellaria. × 350.

25. **Encope emarginata** (Leske).

25. Side view of tip of valve of bidentate pedicellaria. × 350.

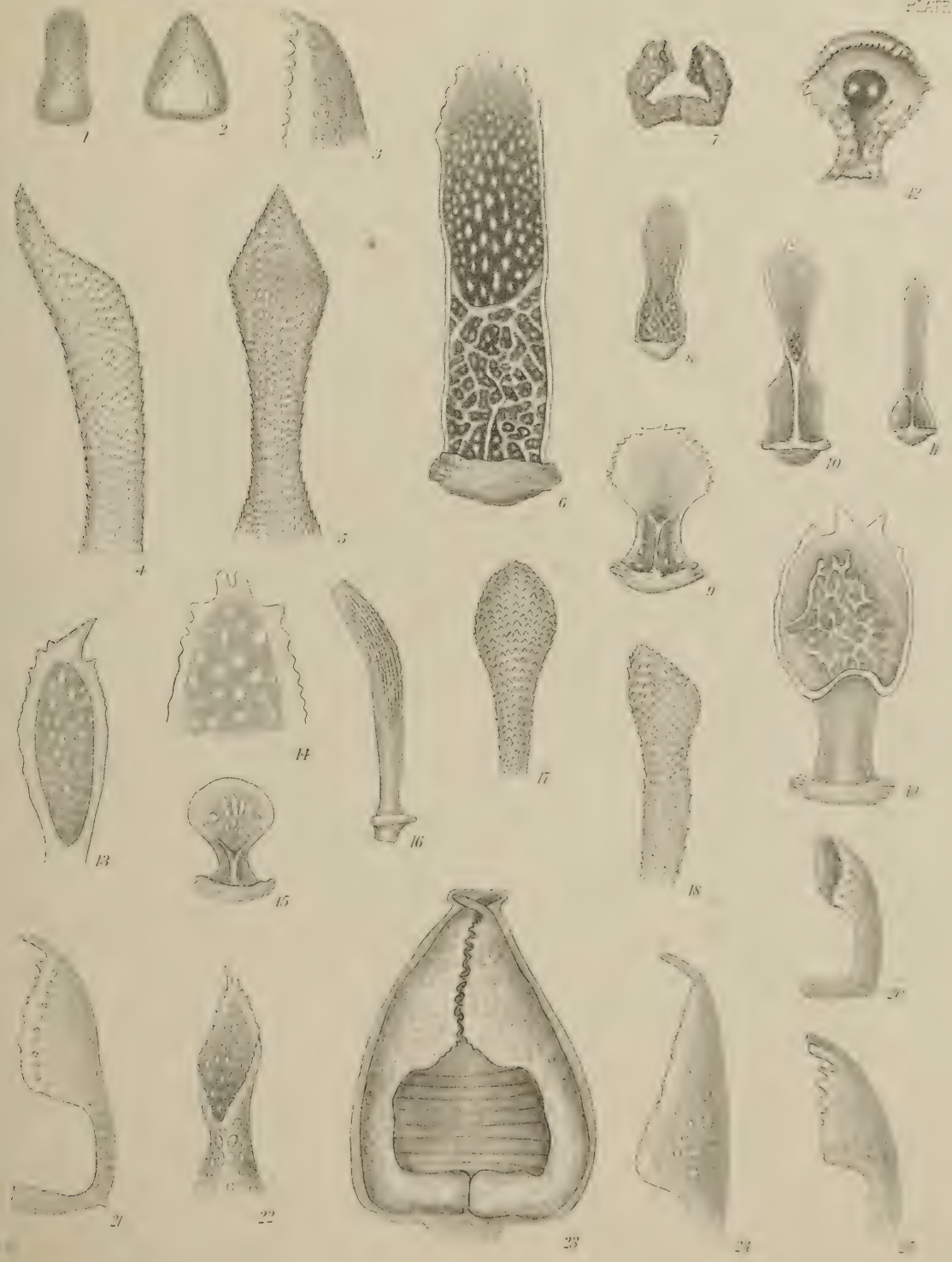
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PLATE **126.**

PLATE 126.

1–4. **Fibularia acuta** Yosh. × 6.

1. Abactinal surface of bare test of specimen from Asamiwan, Tsu-shima, Japan.
2. Actinal surface of same.
3. Interior view of actinal half of same.
4. Right-side view of same.

5–8. **Echinocyamus megapetalus** H. L. Clark. × 6.

5. Abactinal surface of bare test of specimen (holotype) from Mauritius.
6. Actinal surface of same.
7. Interior view of actinal half of same.
8. Right-side view of same.

9–11. **Echinocyamus elongatus** H. L. Clark. × 6.

9. Abactinal surface of bare test of specimen (holotype) from Hawaii, St. 3846.
10. Actinal surface of same.
11. Right-side view of same.

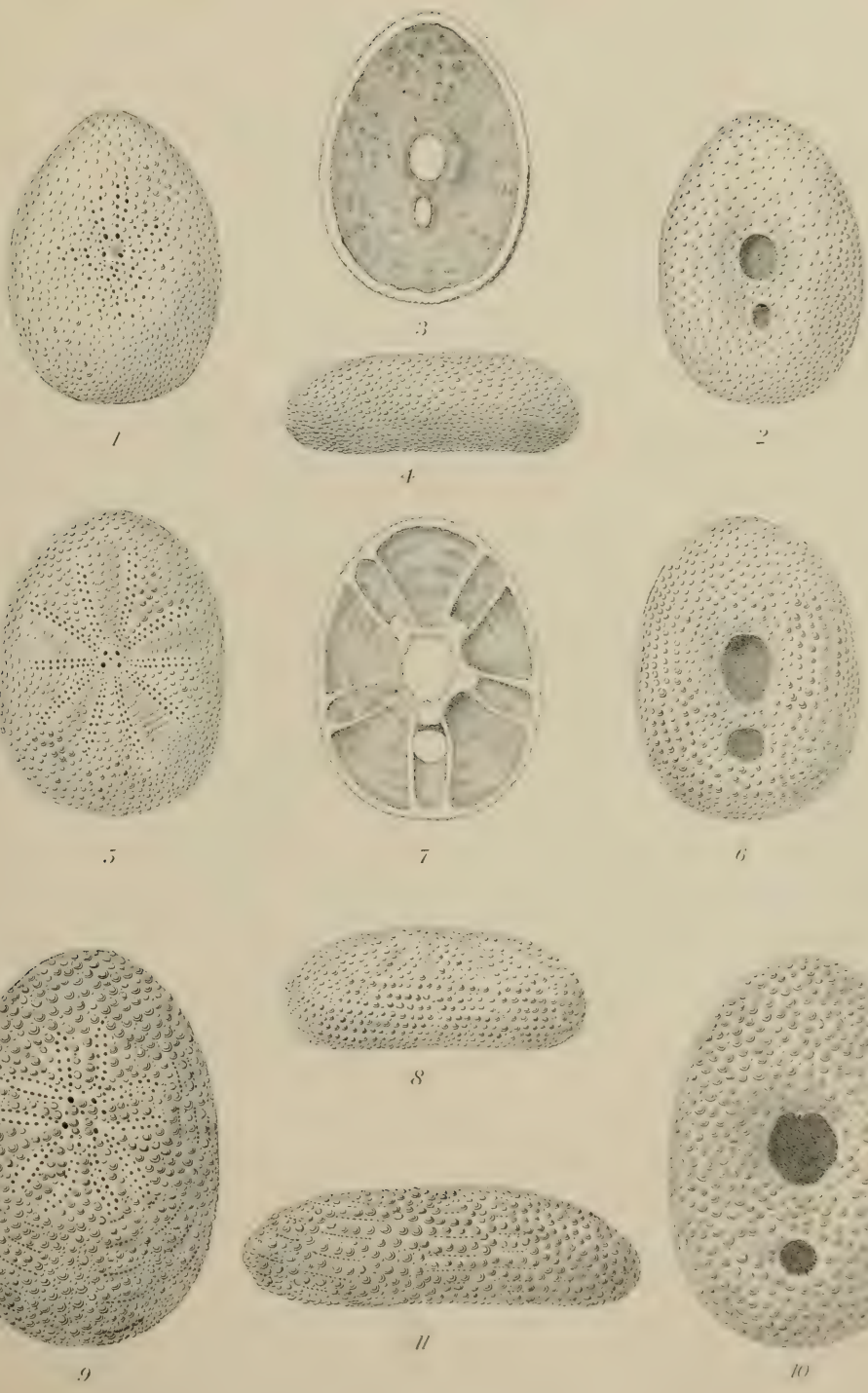
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PLATE **127.**

PLATE 127.

1–6. **Echinocyamus platytatus** H. L. Clark.

1. Abactinal surface of bare test of specimen (holotype) from Portsea, Victoria. × 6.
2. Actinal surface of same. × 6.
3. Interior view of actinal half of same. × 6.
4. Right-side view of same. × 6.
5. Abactinal system of male, showing small genital pores. × 12.
6. Abactinal system of female, showing large genital pores. × 12.

7, 8. **Laganum fudsiyama** Död.

7. Right anterior petal, showing coarse tuberculation. × 5.
8. Abactinal system. × 6.

9–12. **Laganum diploporum** A. Ag. & Cl.

9. Right anterior petal, showing fine tuberculation. × 5.
10. Abactinal system, showing double genital pore in posterior interambulacrum. × 10.
11. Abactinal system, showing two distinct genital pores in posterior interambulacrum. × 10.
12. Abactinal system, showing two well-separated genital pores in posterior interambulacrum. × 10.

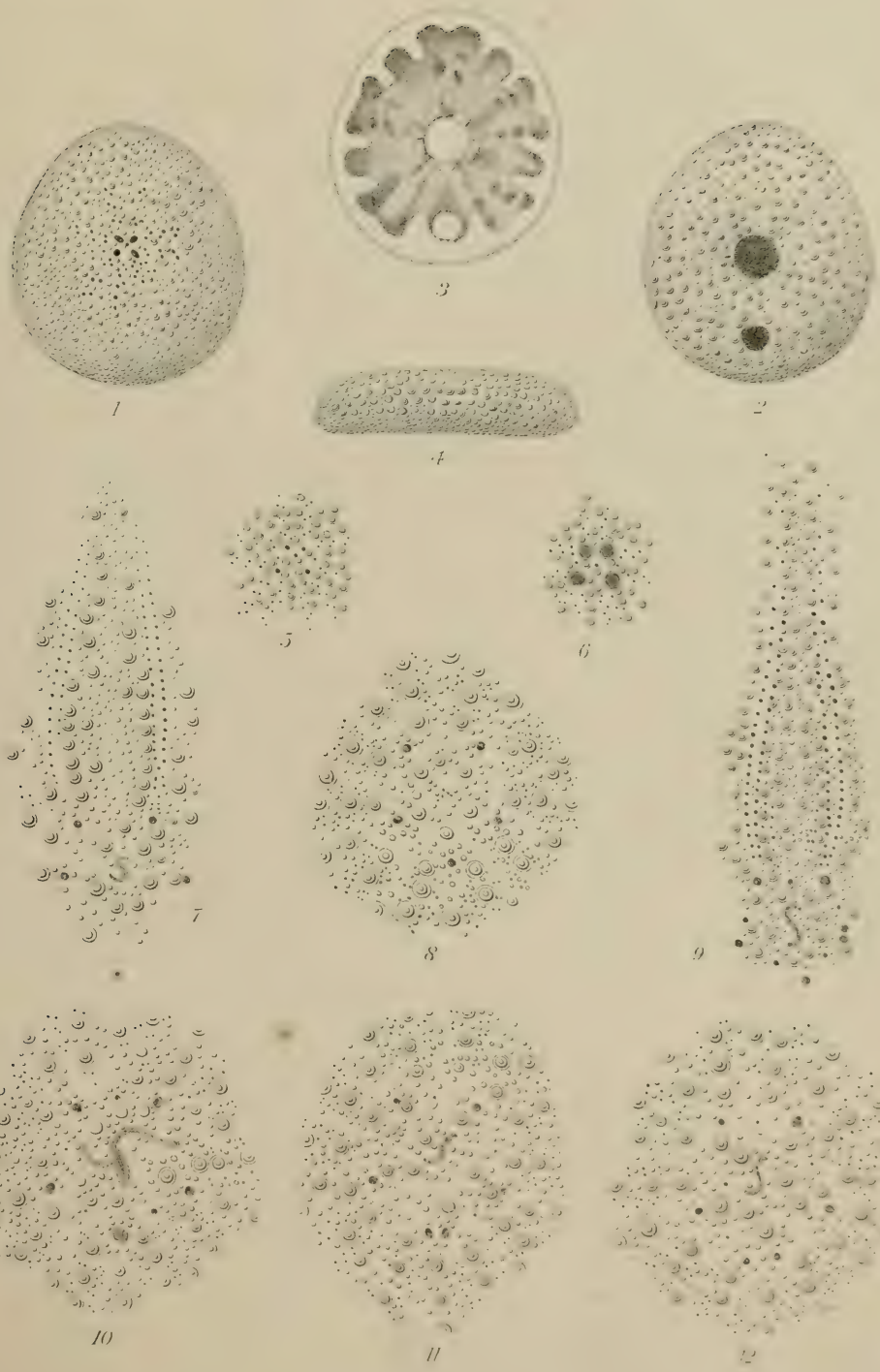
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PLATE **128.**

PLATE 128.

1–3. **Echinocyamus incertus** H. L. Clark. × 6.

1. Abactinal surface of bare test of specimen (holotype) from Hawaii, St. 4045.
2. Actinal surface of same.
3. Right-side view of same.

4. **Clypeaster australasiae** (Gray).

4. Part of right poriferous area of anterior petal. × 5.

5. **Clypeaster japonicus** Död.

5. Part of right poriferous area of anterior petal. × 5.

6. **Clypeaster rotundus** (A. Ag.).

6. Part of right poriferous area of anterior petal. × 5.

7. **Clypeaster speciosus** Verr.

7. Part of right poriferous area of anterior petal. × 5.

8. **Clypeaster virescens** Död.

8. Part of right poriferous area of anterior petal. × 5.

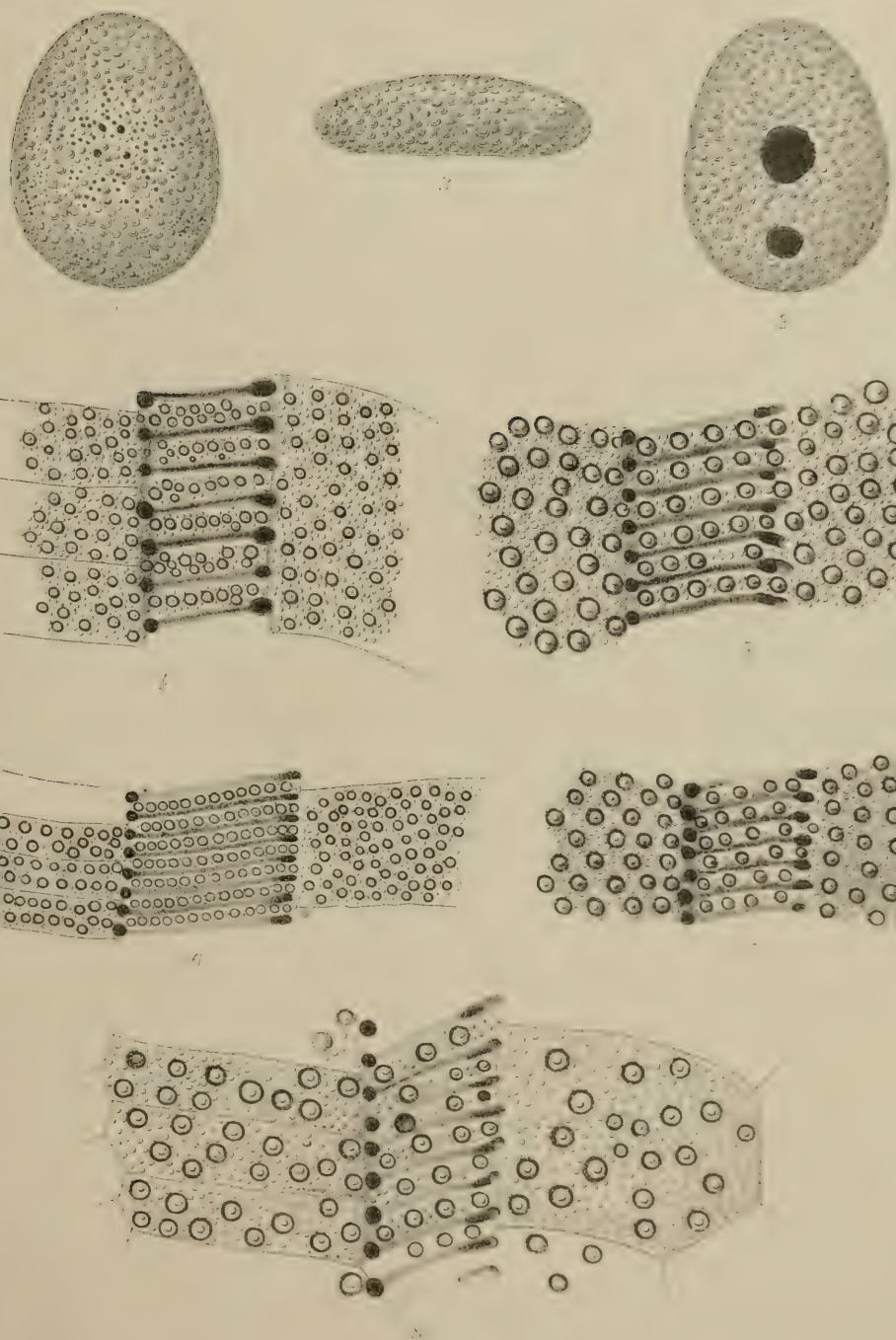


PLATE 129.

Clypeaster europacificus H. L. Clark.

Abactinal view of partly denuded specimen (holotype) from the Gulf of Panama, 33 fms., St. 2795.

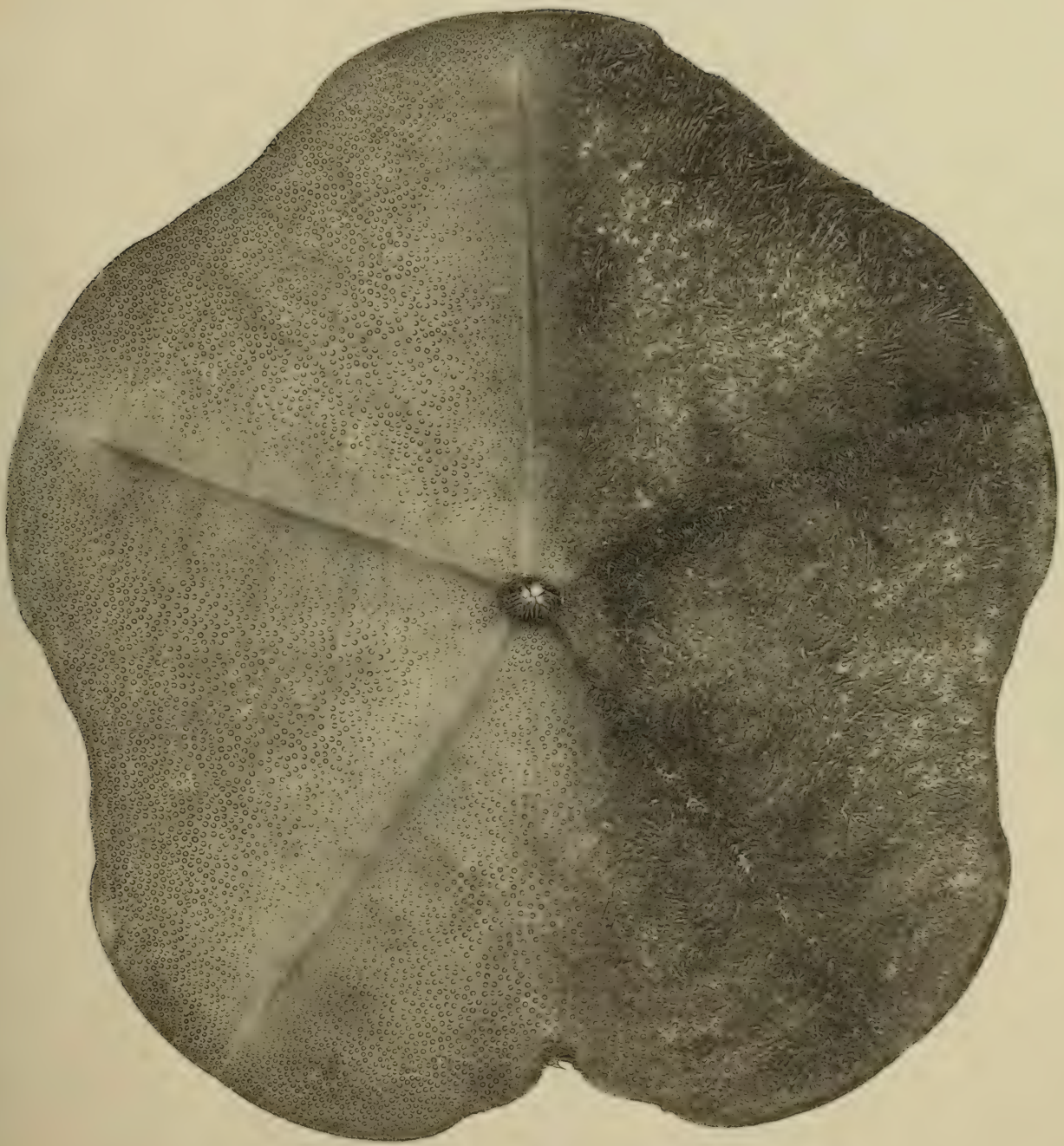
Natural size.

Heliotype Co Boston

PLATE 130.

Clypeaster europacificus H. L. Clark.

Actinal view of same specimen as that shown on Plate 129.
Natural size.



Heliotype Co. Boston.

PLATE 131.

Clypeaster europacificus H. L. Clark.

1. Abactinal view of denuded test of specimen from Gulf of California, St. 3014.
2. Right-side view of same specimen as that shown on Plates 129 and 130.

Natural size.

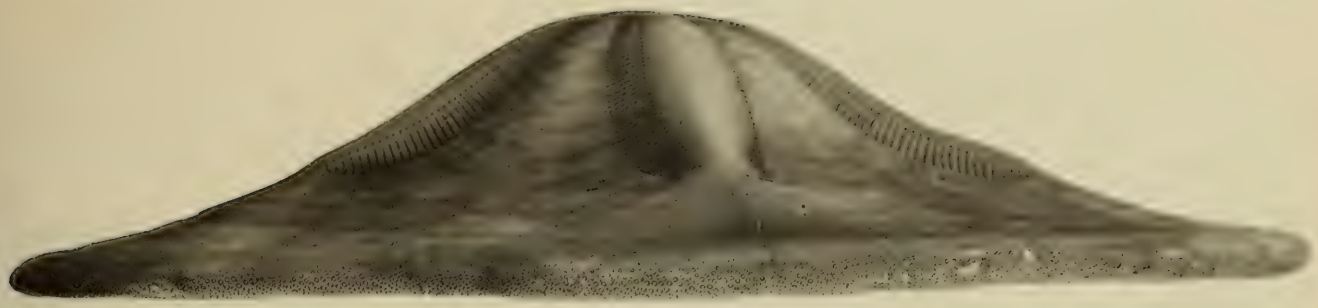


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PLATE **132.**

PLATE 132.

Clypeaster rotundus (A. Ag.).

Abactinal view of partly denuded, large specimen from Gulf of Panama, St. 2796. Natural size.

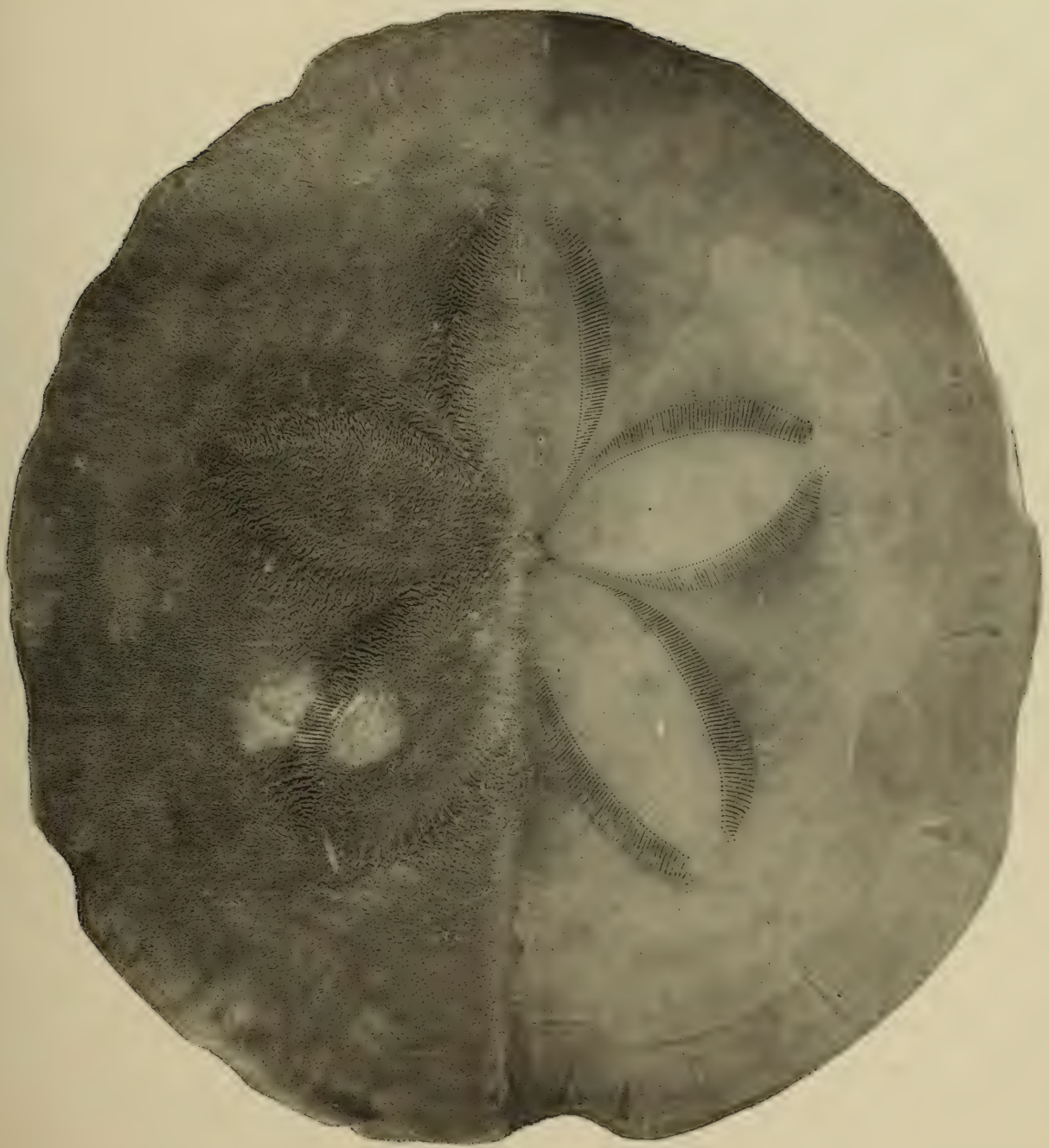

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PLATE 133.

Clypeaster rotundus (A. Ag.).

1. Actinal view of same specimen as that shown on Plate 132.
2. Right-side view of same specimen.

Natural size.

2

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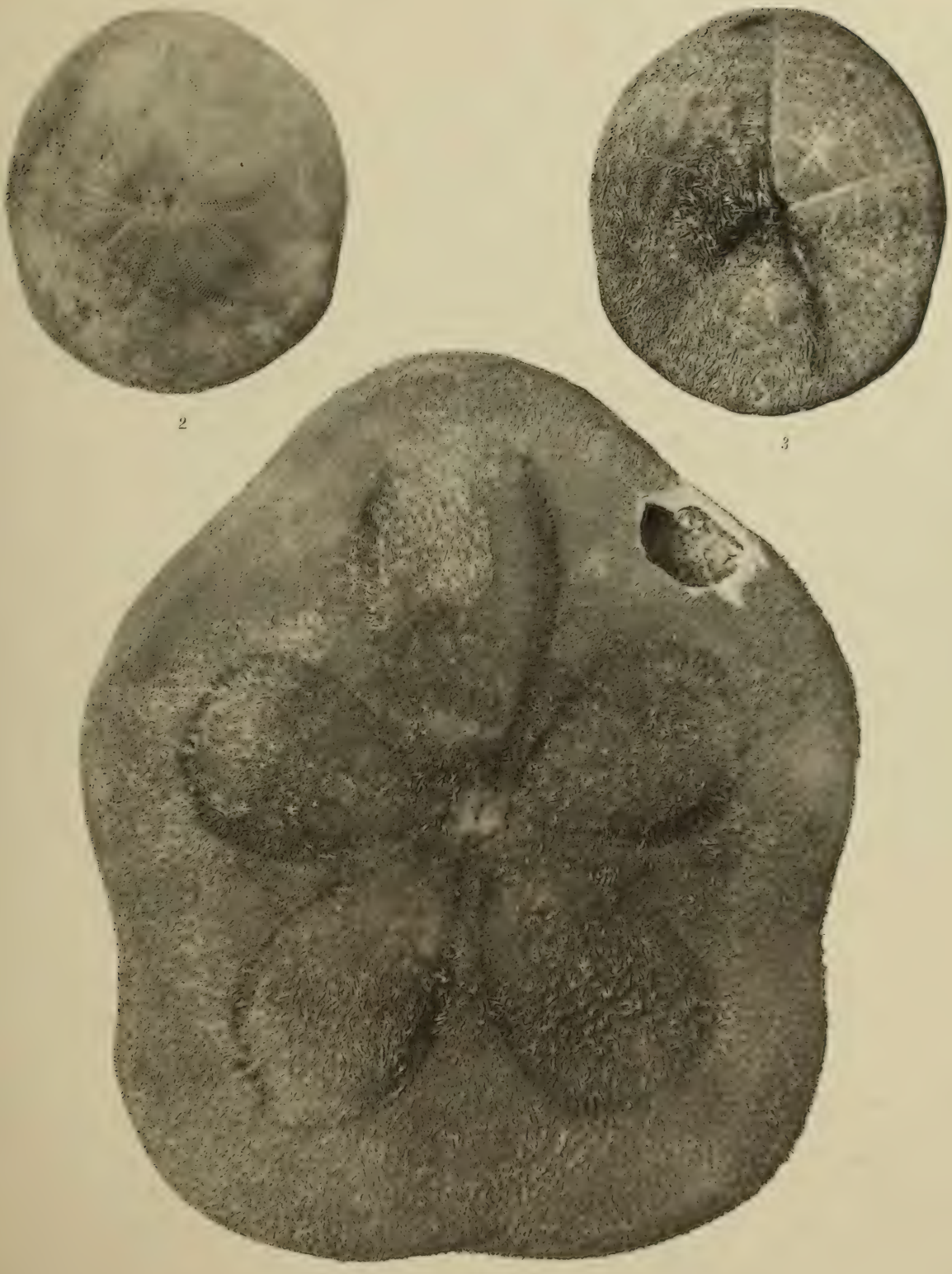
PLATE **134.**

PLATE 134.

1–3. **Clypeaster australasiae** (Gray).

1. Abactinal view of large adult specimen from Port Jackson, New South Wales.
2. Abactinal view of young specimen from Port Jackson, New South Wales.
3. Actinal view of same.

Natural size.



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Heliotype Co. Boston

PLATE 135.

1, 2. **Clypeaster speciosus** Verrill.

1. Abactinal view of bare test of specimen from Magdalena Bay, Lower California.
2. Actinal view of same.

3–5. **Clypeaster leptostracon** A. Ag. & Cl.

3. Actinal view of partly denuded specimen (holotype) from Hawaii, St. 4046.
4. Right-side view of same.
5. Abactinal view of same.

6. **Clypeaster australasiae** (Gray).

6. Right-side view of same specimen as that shown in fig. 2, Pl. 134.

All figures, natural size.

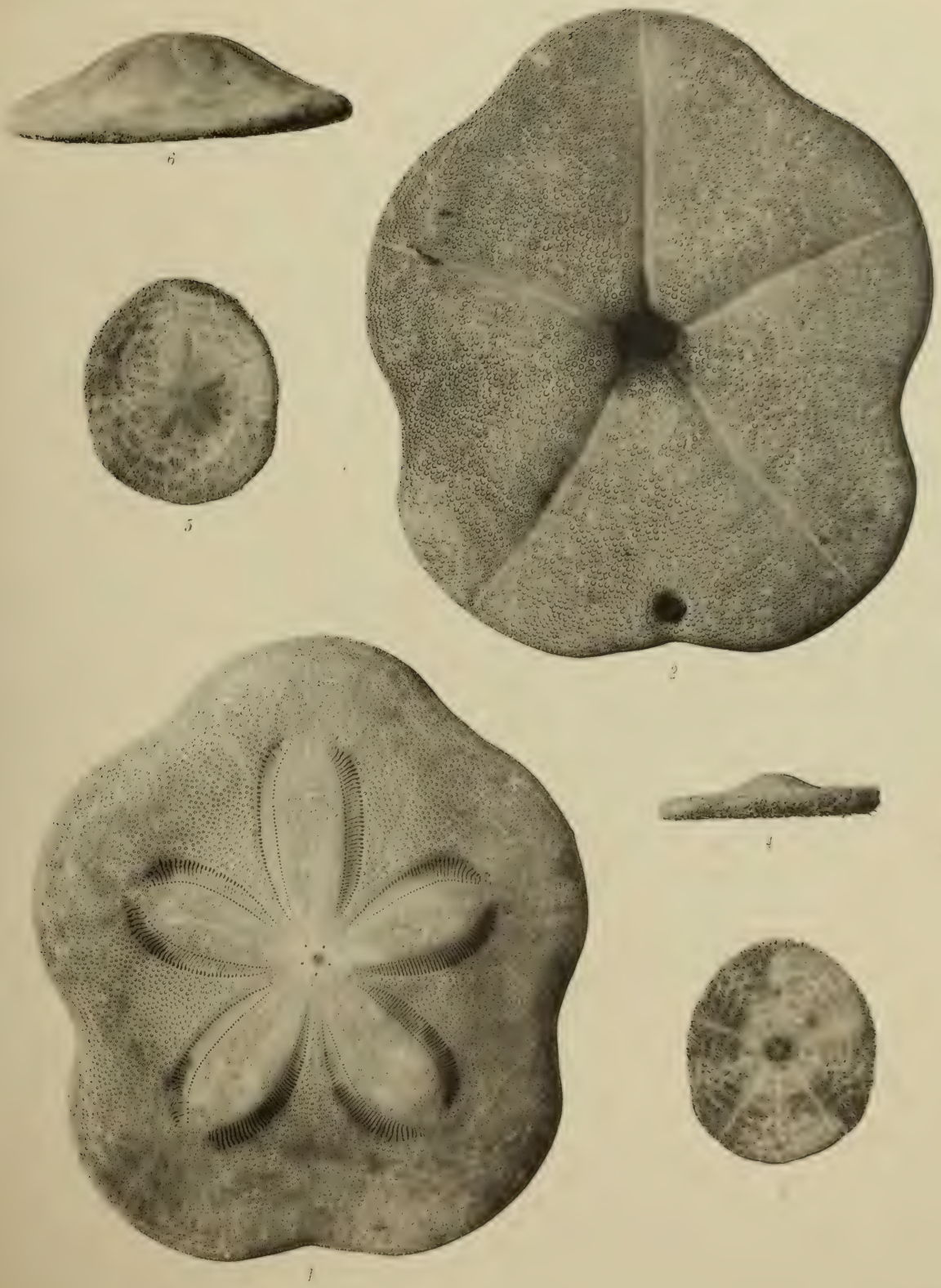

PLATE **136.**

PLATE 136.

1. **Clypeaster europacificus** H. L. Clark.

1. Abactinal view of partly denuded young specimen from Gulf of Panama, St. 2795.

2–4. **Clypeaster japonicus** Död.

2. Right-side view of bare test of long specimen from Tokyo, Japan.
3. Abactinal view of same.
4. Actinal view of same.

5. **Clypeaster speciosus** Verrill.

5. Right-side view of bare test; same specimen as that shown in fig. 1, Plate 135.

All figures, natural size.

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Heliotype Co Boston

PLATE 137.

PLATE 137.

Clypeaster humilis (Leske).

1. Abactinal view of bare test of specimen from unknown locality.
2. Right-side view of same.

Natural size.

2

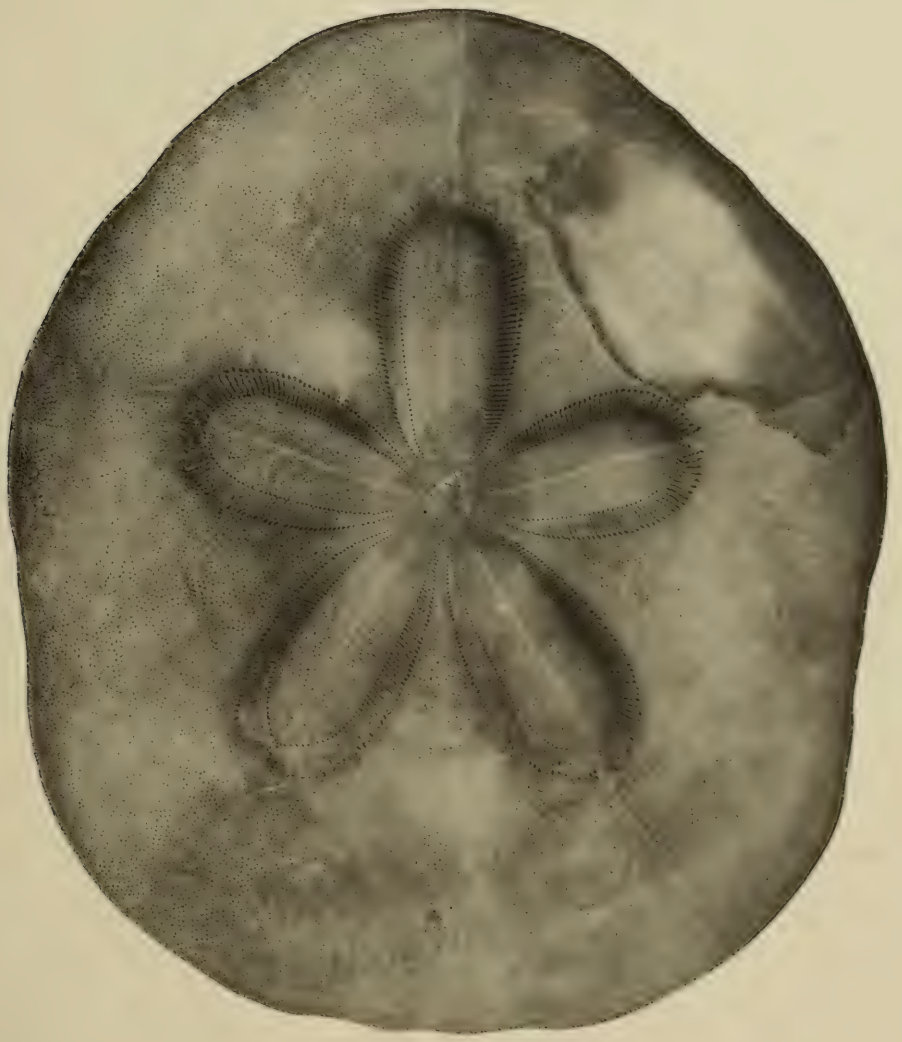

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PLATE 138.

PLATE 138.

1–3. **Clypeaster lytopetalus** A. Ag. & Cl.

1. Abactinal view of partly denuded test of specimen (holotype) from Hawaii, St. 3962.
2. Actinal view of same.
3. Left-side view of same.

4. **Clypeaster humilis** (Leske).

4. Actinal view of same specimen as that shown in fig. 1, Pl. 137.

5. **Clypeaster japonicus** Död.

5. Left-side view of partly denuded test of unusually high specimen from Sagami Sea, Japan.

All figures, natural size.

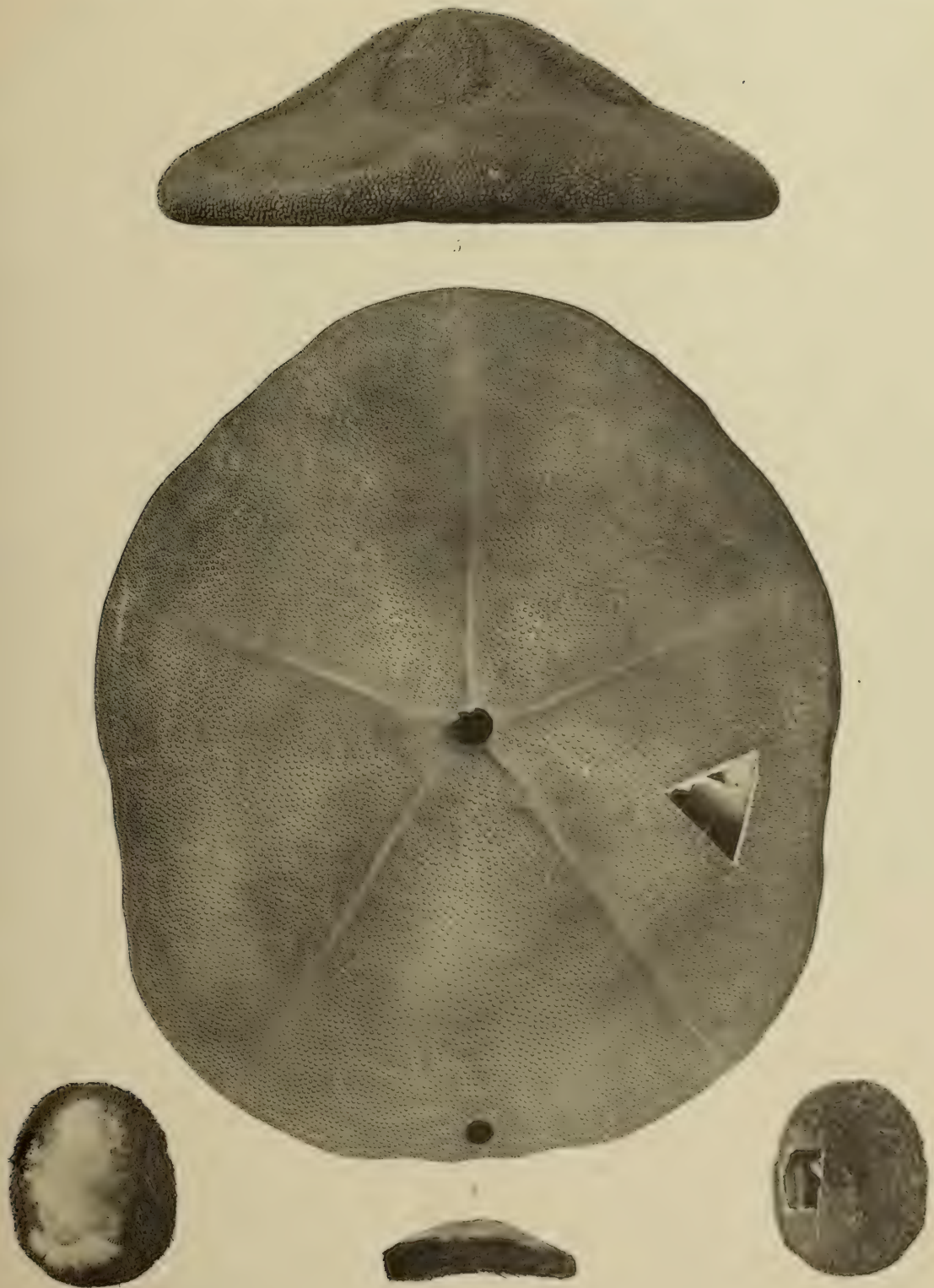


PLATE 139.

PLATE 139.

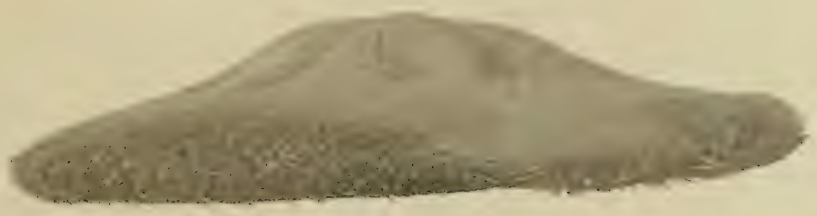
1–3. **Clypeaster pallidus** H. L. Clark.

1. Abactinal view of partly denuded specimen (holotype) from Barbados, 94 fms.
2. Actinal view of same.
3. Right-side view of same.

4. **Clypeaster virescens** Död.

4. Right-side view of partly denuded specimen from Japan, St. 5071.

All figures, natural size.



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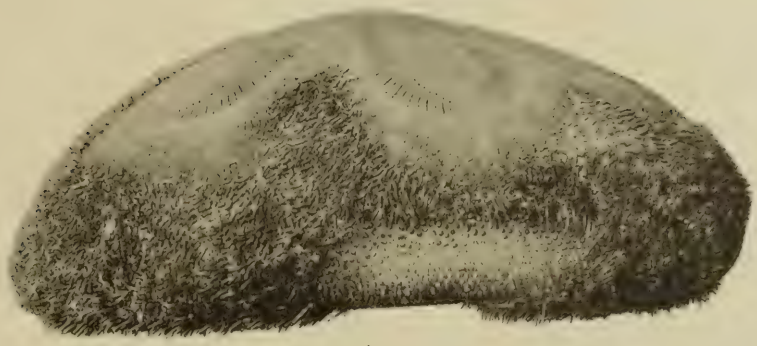

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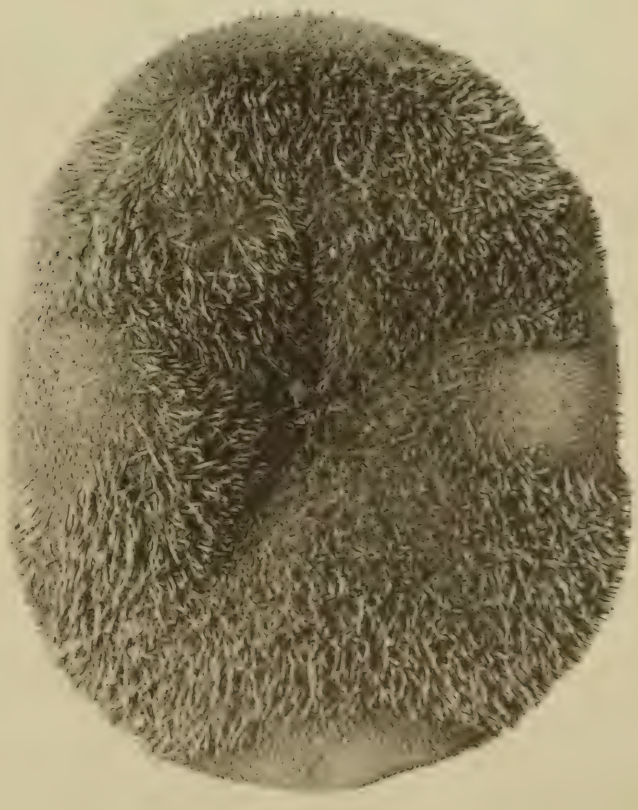

2

Plate 140.

1, 2. **Clypeaster virescens** Död.

1. Abactinal view of partly denuded specimen; same as that shown in fig. 4, Plate 139.
2. Actinal view of same.

3, 4. **Laganum fudsiyama** Död.

3. Abactinal view of large specimen from Japan, St. 5091.
4. Abactinal view of denuded specimen from Japan, St. 4965.

All figures, natural size.

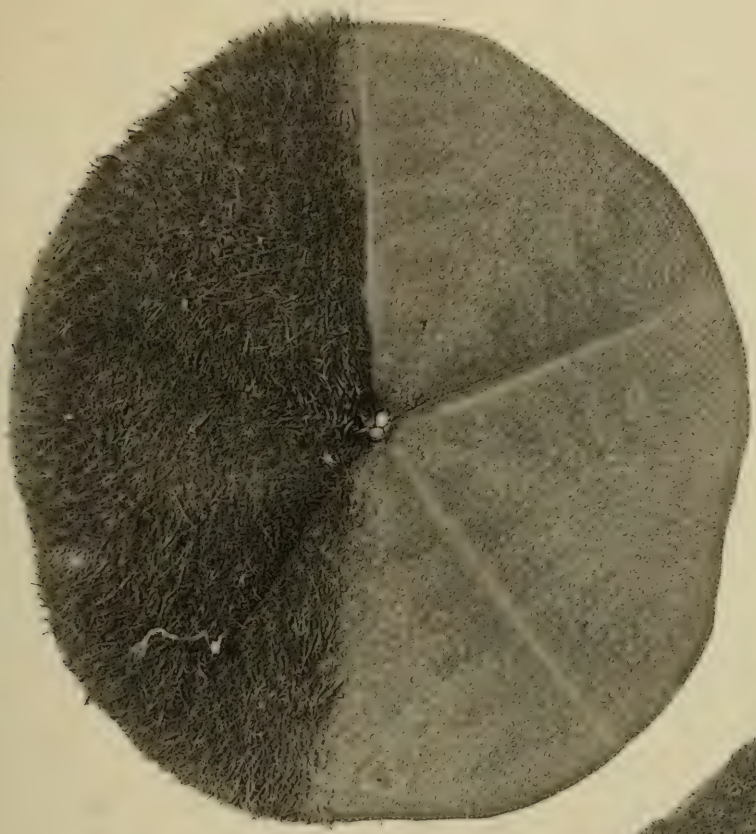

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Plate 141.

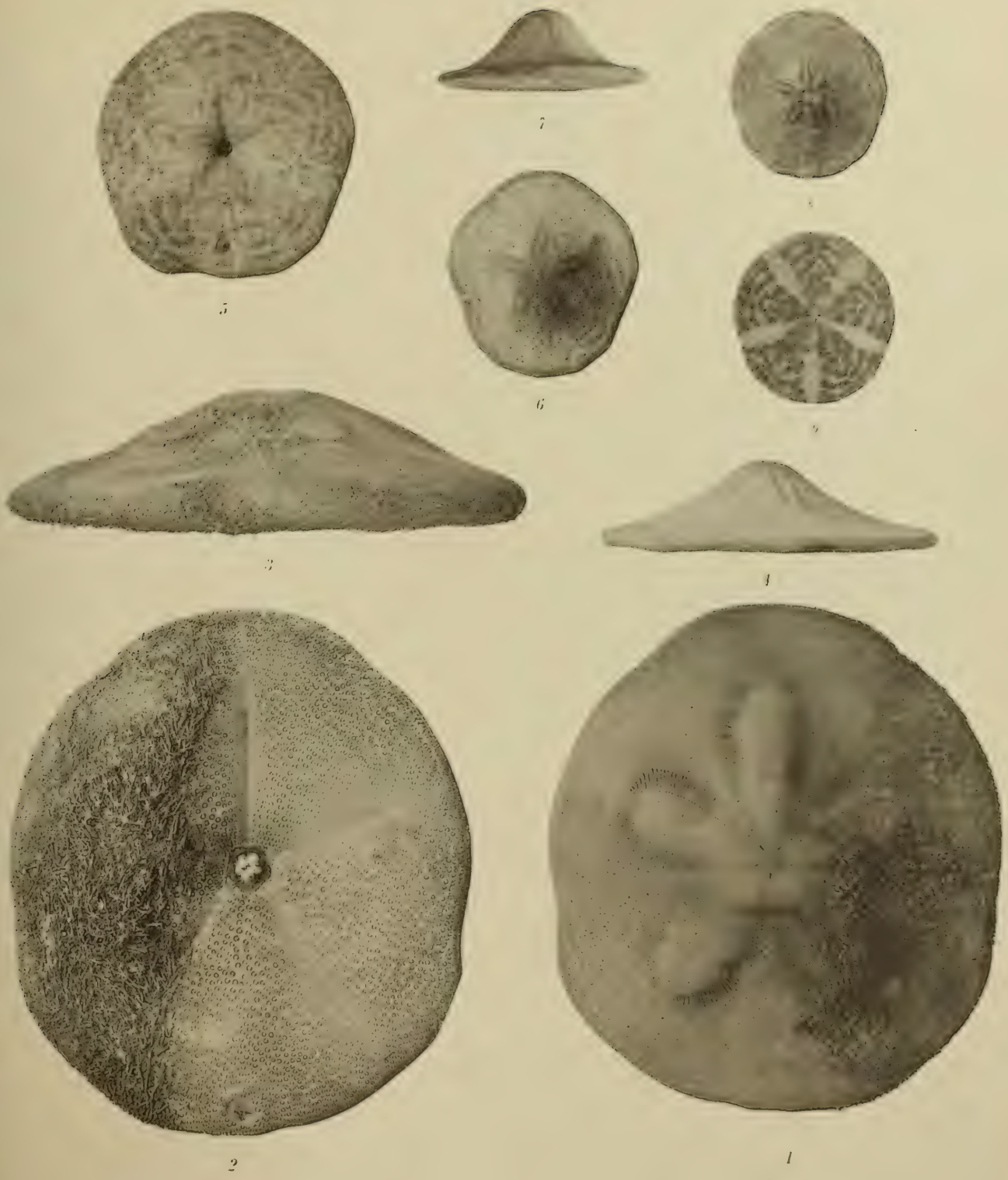
1–3. **Clypeaster ochrus** H. L. Clark.

1. Abactinal view of partly denuded specimen (holotype) from Acapulco, Mexico.
2. Actinal view of same.
3. Right-side view of same.

4–9. **Laganum fudsiyama** Död.

4. Right-side view of same specimen as that shown in fig. 4, Pl. 140.
5. Actinal view of same.
6. Abactinal view of denuded specimen from Hawaii, St. 4081.
7. Right-side view of same.
8. Abactinal view of a partly denuded specimen from Hawaii, St. 4080.
9. Actinal view of same, showing color-pattern.

All specimens, natural size.



Halvorsen Co. Bergen

PLATE 142.

PLATE **142.**

PLATE 142.

1, 8–10. **Peronella pellucida** Död.

1. Abactinal view of partly denuded adult specimen from Uraga Channel, Japan, 20 fms.
8. Actinal view of another specimen from Japan.
9. Right-side view of same.
10. Abactinal view of same.

2–4. **Laganum diploporum** A. Ag. & Cl.

2. Actinal view of partly denuded specimen (holotype) from Japan, St. 3707.
3. Abactinal view of same.
4. Right-side view of same.

5–7. **Peronella rubra** Död.

5. Abactinal view of partly denuded adult specimen from Uraga Channel, Japan, 20 fms.
6. Actinal view of same.
7. Right-side view of same.

11–13. **Peronella strigata** (A. Ag. & Cl.).

11. Abactinal view of specimen (holotype) from Hawaii, St. 3859.
12. Actinal view of same.
13. Right-side view of same.

14–16. **Laganum putnami** A. Ag.

14. Abactinal view of specimen from Ousima, Japan.
15. Actinal view of same.
16. Right-side view of same.

All figures, natural size.

Huntington Co. Boston.

PLATE **143.**

PLATE 143.

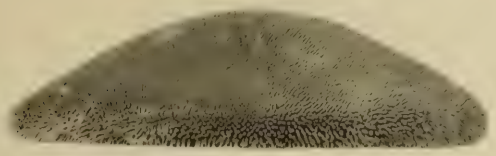
1–4. **Echinarachnius asiaticus** Mich.

1. Abactinal view of partly denuded specimen from Kamtchatka, St. 3781.
2. Right-side view of same.
3. Actinal view of same.
4. Right-side view of another specimen from same station.

5–8. **Echinarachnius parma** var. **obesa** H. L. Clark.

5. Abactinal view of partly denuded specimen from Kamtchatka.
6. Right-side view of same.
7. Actinal view of same.
8. Right-side view of specimen from Komandorski Islands, St. 4786.

All figures, natural size.



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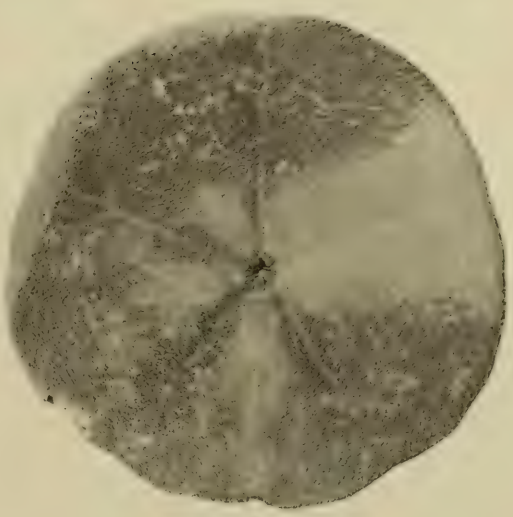

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Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XLVI. No. 2.

HAWAIIAN AND OTHER PACIFIC ECHINI.

THE ECHINONEIDAE, NUCLEOLITIDAE, URECHINIDAE, ECHINOCORYTHIDAE, CALYMNIDAE, POURTALESIIDAE, PALAEOSTOMATIDAE, AEROPSIDAE, PALAEOPNEUSTIDAE, HEMIASTERIDAE, AND SPATANGIDAE.

BY

HUBERT LYMAN CLARK.

WITH EIGHTEEN PLATES.

Plates 144–161.

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CAMBRIDGE, U. S. A.:
Printed for the Museum.
March, 1917.

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† New species.

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† New species.

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HAWAIIAN AND OTHER PACIFIC ECHINI.

Collected by the U. S. Fish Commission Steamer Albatross, Commander Chauncey Thomas, U. S. N., Commanding, in 1902 and Lieut. Commander L. M. Garrett, U. S. N., Commanding in 1906.

SPATANGINA Jackson.

General Characteristics.

It must be admitted that the Spatangina do not make up a monophyletic group equivalent to the Clypeastrina. The name is used here, as it was by Jackson, to include all those Echini of the Exocycloida which do not belong in either the Holectypina or Clypeastrina. From how many ancestral stocks this group has sprung, we are not yet in a position to say. Hawkins, in his most interesting and valuable paper, on the Holectypoida (1912, Proc. Zool. Soc. London, p. 493) expresses the opinion that there are no fewer than four distinct branches combined in this highly artificial group. My own impression is that probably three lines of descent are concerned, but it is quite possible that we are exaggerating differences and that in reality only two essentially different stocks have contributed to the Spatangina. In that case it will be easy to adapt our classification to the facts.

The Spatangina are easily distinguished from all other Recent Echini by the entire absence of a lantern or any trace of jaws. The occurrence of jaws in *very young* Echinoneus (see A. Agassiz, 1909. Amer. Journ. Sci., ser. 4, 28, p. 490) only serves to emphasize this fundamental character. Aside from this the mouth and peristome exhibit notable diversity in form and position. The peristome may be circular, pentagonal, elongate-ellipsoidal, or oblique but is usually transversely longest and more or less reniform. The remarkably regular and characteristic arrangement of ambulacral plates around the peristome, discovered by Lovén by which Ia, IIa, IIIb, IVa and Vb are always larger than their companion plates and have two pore-pairs instead of one, requires no comment other than to say that there seems no exception to this rule. In most Spatangina, the peristome is distinctly anterior, and it may even be

terminal, but on the other hand it is sometimes central and very rarely back of the center. It is usually more or less sunken, occasionally to an extraordinary degree but on the other hand it is often nearly or quite flush with the oral surface. The peristomial membrane is usually more or less calcified with numerous irregular small plates; these, however, are *sui generis* and not homologous with any plates of the test. Occasionally the membrane is quite naked, while in Palaeostoma, the other extreme is reached, the mouth being completely concealed beneath five triangular, presumably movable plates.

When the peristome is anterior, the interradius directly posterior to it (interambulacrum 5) is commonly more or less modified to form a sort of creeping surface called the sternum. If the interambulacra are all alike or approximately so, the animal is said to be *asternous*. In asternous forms, each interambulacrum retains, at the edge of the peristome, the single primordial interambulacral plate followed at once by the pair of plates of series 2. In the forms with a sternum, however, one or more of the interambulacra may have the primordial interambulacral plate followed by a second unpaired plate. The origin and homology of this second plate is as yet unknown. If present at all it will be found in interambulacrum 5, and it may also occur in all the other interambulacra or only in 1 and 4. In most Spatangina, however, the primordial interambulacral plates are followed (even in 5) by the pair of plates of series 2. Those species which have the primordial plate of 5 followed by a single plate are called *meridosternous* while those in which it is followed by a pair (and they are usually much enlarged so that they are the largest plates of the test) are called *amphisternous*. Further we may call the interambulacra which have the primordial plate followed by a single plate, *meridoplacous*, while those in which it is followed by two plates are *amphiplacous*. In all forms in which the sternum is at all well developed, the primordial plate of interambulacrum 5, has a special form (generally more or less T-shape) and its anterior margin forms the posterior boundary or lip (*labium*) of the peristome; the plate itself is called the labrum. The relative length of the labrum as compared with adjoining ambulacral plates is of considerable taxonomic importance. As a rule, the sternum is covered with primary tubercles and spines, but in some specialized genera, more or less of the anterior half may be quite bare. The tube-feet about the mouth are generally enlarged and developed into curious tactile brushes. These enlarged feet are naturally associated with enlarged pores and peripodia. When these enlarged pores are numerous, and especially if they are at all crowded, they form a somewhat petal-like group in each

ambulacrum extending outward from the peristome, called a *phyllode*. The interradial areas between the phyllodes may become swollen and conspicuous and are then called *bourrelets*. The whole group of phyllodes and bourrelets is called a *floscelle*. The floscelle is a taxonomic feature of great importance in asternous forms, especially among the many fossil species.

In all Recent Spatangina the periproct is outside and posterior to the genito-ocular ring, which is thus a more or less compact group of plates, often called the apical system. In many meridosternous forms the apical system may be invaded by interradial plates and oculars I and V be quite separated from the rest of the genito-ocular group; such a system is called disconnected; or genitals 1 and 4 may push in and meet in the mid-line separating oculars I and V from the anterior oculars, but remaining in contact with them; such a system is elongate. In most spatangoids, however, it is compact and usually occupies little space. Genital 5 is always wanting and its accompanying genital gland also. The genital gland and pore in plate 2 is frequently wanting and occasionally in 3 also. In some species, at least, the genital pores appear in genitals 1 and 4 before they do in 2 and 3 and in 3 before they do in 2, but of how many species or genera this is true we have no idea. As a rule genital 2 contains the madreporic pores (indeed I know of no exception) and it is distinctly the largest of the genital plates. It extends backward in the mid-line between oculars II and IV; if it does not separate oculars I and V also, the apical system is said to be *ethmophract* but if, as is usually the case, it stretches backward between I and V into interambulacrum 5, the system is said to be *ethmolytic*.

The periproct may lie on the dorsal surface in interambulacrum 5 (it is always in this area) and in such cases is usually in a depression or groove. It may be at the ambitus or it may be on the oral surface and occasionally close to the mouth. It is always covered by a plate-bearing membrane; the plates nearest the anus are smallest, those in the outermost series are commonly the largest and may be very large and reduced to three in number. In most spatangoids the posterior end of the test is more or less truncate and the periproct is located on that vertical or oblique surface. Below it there is often a group of modified plates forming the subanal plastron; the tube-feet accompanying some of the ambulacral plates entering into the composition of this plastron are enlarged and more or less penicillate (like those near the mouth); the number of ambulacral plates and big tube-feet in the subanal plastron is an important taxonomic character, but in some species at least it increases with age or size.

There is no group of Echini which shows such diversity in shape of the test as the Spatangina. Some species are nearly spherical while some are greatly flattened. In the Pourtalesiidae the test becomes extremely elongated, reaching the limit in the almost tubular Echinosigra. As a rule the longitudinal axis is longer than the transverse, while the latter exceeds the vertical. Ambulacrum III is very often depressed below the level of the adjoining interambulacra and thus the ambitus at the anterior end of the test is more or less distinctly notched; when the test is also depressed the outline is thus somewhat heart-shaped whence the name "heart-urchin," sometimes applied to spatangoids. The modification of the dorsal ends of the ambulacra to form "petals," as in the Clypeastrina, is characteristic of many Spatangina, especially the more specialized forms of Amphisternata. But there are very many spatangoids in which there is no indication of petals whatever. The presence or absence of petals, their size, form, and completeness, their depression below adjoining interambulacra, and the relative length of the different ones are all matters of great importance in classification.

One of the most characteristic features of spatangoids is the narrow, more or less linear, areas covered by very minute spines and known as fascioles. These are lacking in most asternous and meridosternous forms but are present in most amphisternous species. Unfortunately our terminology does not at present distinguish between the band of minute spines and the band of minute tubercles left when the spines are all rubbed off. Duncan would limit the term to the band of tubercles but I have used the term to cover both this band and the minute spinules borne thereon. The difficulty is not in practise a serious one, as it is easy to speak of "fasciolar spines" if one so desires. There are six kinds of fascioles, the names of which are used in the following pages:—marginal, peripetalous, internal, subanal, lateroanal, and anal. The *marginal* fasciole is very seldom met with in Recent species; it lies at or just above the ambitus and runs around the whole test. The *peripetalous* is very commonly present; it lies on the dorsal side of the test and surrounds the area occupied by the petals; it is never far from the tip of the petals but on the other hand the petals never cross it; in some spatangoids with long petals, it may approach so near the ambitus that it is hard to tell from a marginal fasciole. The *internal* fasciole lies within the area of the petals and limits them at their proximal end; it is found in but few genera. The *subanal* fasciole is found in many genera of both meridosternous and amphisternous spatangoids; it surrounds a circular, transversely ellipsoidal or oblong area below the periproct which is commonly

differentiated as the subanal plastron (p. 93). The *lateroanal* fasciole, when fully developed, is a band which runs from the side of the peripetalous fasciole downward and backward under the periproct and upwards and forwards to the other side of the peripetalous fasciole; it is seldom as complete as this for the connection with the peripetalous fasciole on each side is often wanting, and the lateral portions may be reduced to such an extent that only the piece under the periproct is left; no other fasciole shows as great specific and individual diversity as does this. Mortensen discovered that it is in reality the posterior portion of the original peripetalous fasciole and that the present posterior part of that fasciole (at least in many of the Hemiasteridae) is a cross-band of secondary origin. Obviously then there is no homology between the subanal fasciole and the lateroanal. The *anal* fasciole is made up of bands on each side of the periproct and usually, if not always, these bands appear as branches of the subanal fasciole; they may then be called simply the anal branches. The name anal fasciole is also used sometimes for that part of the lateroanal which lies in the immediate vicinity of the periproct, particularly if its lateral connections with the peripetalous fasciole have disappeared.

The Spines, Pedicellariae, Sphaeridia, and Spicules.

In all Spatangina, there are spines carried on the plates of the test, but their size, number, and distribution is a matter of the greatest diversity. We can recognize primary, secondary, and miliary spines, with their corresponding tubercles, but there is no sharp line between these groups and a spine which would be a primary in one genus might be only a secondary in another. The terms are purely descriptive for convenience and probably have no morphological significance. As a rule, the spines are solid, bluntly rounded, or pointed at the tip. But in some genera the miliaries are *multiscalariform* (*i. e.* made up of a number of rods connected by cross-bars like the rounds of a ladder) as in many of the clypeastroids. Secondaries are oftentimes flattened at the tip, thus becoming spatulate, and these may also be curved. This curved spatulate form is also quite characteristic of the primaries of the oral surface, especially those on the posterior part of the sternum. Secondaries bordering the petals, especially if these are sunken, and those surrounding the periproct, are usually the largest and most conspicuous secondaries on the test. The largest primaries are as a rule on the oral surface, particularly in interambulacra 1 and 4, where those bordering the ambulacra I and V are of maximum size. Similar

large primaries almost always cover more or less of the sternum and not infrequently the posterior oral parts of interambulacra 2 and 4. Primaries do not often occur in the ambulacra and as a rule the oral portions of all the ambulacra are bare, not only of primaries but of secondaries too, and carry only a few widely scattered miliaries. When primary spines occur above the ambitus, they are usually conspicuous and have considerable taxonomic importance. They may attain a considerable length, even up to 90 mm. Such primaries are generally attenuate, often prickly on the distal half and frequently, if not always, are hollow. They are very fragile and it is unusual to find any considerable number of them unbroken in museum specimens. Primaries may be borne singly, only one on each plate, but this is unusual. More commonly several occur on the same plate and sometimes the surface of the plates (on the sternum for example) is completely covered with primary tubercles. It is of interest to note that the large tubercles in spatangoids are nearly always perforate, as in clypeastroids and the primitive regular Echini. In some genera, the primary tubercles become deeply sunken into the test, giving rise to curious swollen rings on its inner surface. Only in Echinoneus are there "glassy tubercles" on the test comparable to those in many clypeastroids.

The *pedicellariae* are extraordinarily diversified but they give little help in the attempt to trace relationships within the group. I have not found it practicable to use them to any extent in defining the larger groups, though they are sometimes useful in distinguishing genera and frequently furnish excellent specific characters. Unfortunately the characteristic forms are often very rare or at least hard to find and they are not infrequently wanting in certain individuals. At least five distinct classes of pedicellariae can be distinguished, the globiferous, ophicephalous, tridentate, rostrate, and triphyllous. The *globiferous* are those which have what appear to be poison-glands associated with each valve; there are always three valves and these usually have a more or less tubular blade and terminate in conspicuous teeth; in some peculiar forms, however, the blade is quite flat though narrow; the glandular tissue may cover the valve or be confined to either its base or its tip; these pedicellariae furnish the best specific characters but unfortunately they are the most frequently missing of the five kinds. Globiferous pedicellariae when present are usually to be found on or beside the bare ventral ambulacra. But they may occur about the peristome or on or near the periproct.

The *ophicephalous* pedicellariae are also very frequently wanting, but when present often furnish excellent specific characters. It is a very inter-

esting point that in several genera, ophicephalous pedicellariae are present often abundantly in young specimens, and are totally lacking in adults. This fact is probably of phyllogenetic significance. When present, ophicephalous pedicellariae are more generally found on the posterior part of the test especially in the ambulacra, and more commonly on the oral side but they may be found in some species almost anywhere; they always have three valves. The *tridentate* are the most generally present, the most extraordinarily diversified and the most uniformly distributed of the pedicellariae, but they may be quite wanting and not infrequently seem to be uncommon or hard to find. Of course, they typically have three valves but a bidentate form is known in at least one species, and forms with 4, 5, 6, 7 or even 8 valves are not uncommon in some genera. These multidentate forms are of considerable interest and may afford a good specific character. The typical tridentate may be large or small, and stout or slender; the valves may be broad and flat or narrow and greatly compressed; they may be straight or curved, in contact throughout or only at tips, and the margins may be smooth, finely serrate, coarsely serrate, dentate, coarsely toothed, or even lobed. Tridentate pedicellariae occur almost anywhere, but around the periproct or the peristome or along the sides of the ventral ambulacra are the favorite locations. The *rostrate* pedicellariae are a modified form of tridentate, usually quite easily distinguishable by their stout, curved valves meeting only at tip where they are usually more or less widened. Oftentimes it is not easy to draw a line between stout tridentate and rostrate pedicellariae; on the other hand it is sometimes hard to decide whether a given form should be called rostrate or globiferous. The rostrate pedicellariae always have three valves and their distribution is like that of the tridentate; they are generally present. The *triphyllous* pedicellariae are commonly present, but are often difficult to find, owing to their very small size. The valves are flat and leaf-like, but the relative length and breadth of the valves shows some diversity, and they occasionally afford a specific character. The *sphaeridia* occur in all the genera probably; at any rate, I know of none in which they are lacking. They are usually not imbedded in the test nor even placed in pits but lie on the surface of the ambulacral plates, at least those near the mouth. In some genera, however, they are placed in pits of greater or less depth and in a few cases they are really imbedded in the test as in clypeastroids. Neither the form, number, nor position of the sphaeridia seem to furnish any character of taxonomic importance. The *calcareous particles* in the tube-feet afford characters of no importance for systematic purposes. In the ordinary tube-feet they are often quite

wanting. In the penicillate tube-feet about the peristome and on the subanal plastron, calcareous rods are always developed and there may be other calcareous particles present but I have failed to find any of any real significance. As a rule, the calcareous particles (aside from the rods referred to) are irregular perforated plates or more commonly curved rods with more or less conspicuous knobs or other projections scattered over them. The various forms have been well figured by Mortensen (1907. Ingolf Ech., pt. 2).

The Families of Spatangina.

A satisfactory classification of the Echini here included in the Spatangina is in the present state of our knowledge simply impossible. Mortensen's researches into the growth changes of several species have thrown a great deal of light on some perplexing questions but until we know something of the growth changes in many other genera, particularly some of those with a subanal fasciole, we are groping in the dark in the attempt to arrange the genera in natural groups. The simple classification of the Revision in which only two families were recognized does not meet the needs of our present situation, while the classifications of later writers (Duncan, Meissner, Gregory, MacBride) are largely based on characters, concerning the phylogenetic value of which we are still quite in the dark. The classification used by Jackson in the 1913 edition of the Eastman-Zittel Text-book of Paleontology (p. 283–298) represents the best summing up of our knowledge that has yet appeared, including as it does all the Fossil as well as the Recent forms. But I have been unable to use it because it seems to do violence to certain natural relationships, particularly in the division of the Spatangidae into four sections based on the presence or absence of certain fascioles.

After very long and deliberate consideration of the available facts, so far as the Recent forms are concerned, I have determined not to recognize groups larger than the family in the Spatangina. The classification adopted is purely one of convenience, worked out in the endeavor to make an artificial key to all the genera and species of living spatangoids. A large part of the data were derived from Mortensen's important publications and the key to the meridosternous families is taken almost bodily from him. But I have examined both test and pedicellariae in nearly all the genera and in a large proportion of the species, so that the various keys are based on first-hand information so far as possible. In recognizing eleven families, I am well aware

of their unequal value but I think further knowledge will increase rather than decrease the number.

The weight given to the various characters is the point at which the "personal equation" enters most largely into the composition of the following key to families. I consider the fundamental make-up of the test as the matter of first importance, and except for convenience, should place the meridoplacous or amphiplacous character of the interambulacra, as the primary feature in dividing the genera into groups. For convenience at least, it is better to first remove the genera in which interambulacrum 5 is not differentiated at all to form a sternum. Next the position and covering of the peristome should be considered, and the development of a floscelle or of a distinct labium on its posterior margin. The modifications of the ambulacra to form petals and their accompanying depression seems of next importance but here the possibility that absence of any depression and incompleteness of the petaloid form may not necessarily be the primitive condition in a given group is puzzling. We have no proof to show that it is not a derived condition, a reversion, in some genera, as I strongly suspect it is. Next there are the fascioles, and here again, until more data on growth changes are available, we are quite in the dark as to what are primitive and what are specialized conditions. I feel inclined to think that the subanal fasciole is a very old one, perhaps the oldest, and its presence or absence is therefore of more significance than the presence or absence of any other. Next I rank the peripetalous fasciole but I am in doubt as to whether this precedes the marginal or not. We know the history of the lateroanal, and there is no question that the presence of an internal fasciole, or of anal branches to the subanal fasciole, is a highly specialized feature. The real difficulty then as regards the fascioles is the original relation between marginal, peripetalous, and subanal.

In the use of the following key, it will soon appear that no one character can be relied on for separating the amphisternous families. It ultimately becomes a question of judgment, one might almost say opinion, as to whether ambulacra are petaloid or not, whether they are depressed or not, and to which of these two features, the more weight should be given. The recognition of the Palaeopneustidae results in the arbitrary separation of Palaeopneustes from Linopneustes, and of Homolampas from Lovenia and in both cases violence is done to the truth. Yet the Palaeopneustidae is a natural family and we shall some day understand its history well enough to define it without being guilty of the inconsistencies present in the classification here used. If the

following grouping of the families and genera of Spatangina does but blaze the way towards a natural classification of the group, its purpose is accomplished. I can only hope it is not headed in the wrong direction.

Key to the Families of Spatangina.

Interambulacrum 5 not essentially different orally from the other interambulacra (*Asternata*).
- Ambulacra not at all petaloid; peristome oblique; periproct on oral surface close to mouth . . . . . ECHINONEIDAE
- Ambulacra subpetaloid; peristome not oblique; periproct near or above margin . . . . . NUCLEOLITIDAE

Interambulacrum 5 modified orally to form a sternum.
- Labrum followed by a single plate (*Meridosternata*).
  - Mouth horizontally placed on oral surface of test.
    - Interambulacra all meridoplacous . . . . . URECHINIDAE
    - Interambulacra 2 and 3 amphiplacous.
      - Ambulacral pores in pairs . . . . . ECHINOCORYTHIDAE
      - Ambulacral pores simple . . . . . CALYMNIDAE
  - Mouth vertical at the end of an oral furrow or invagination . . . . POURTALESIIDAE
- Labrum followed by a pair of nearly, or quite, equal, large plates (*Amphisternata*).
  - Peristome approximately circular or pentagonal with unmodified interambulacral plates around it and with no indication of a labrum (except in Aceste); no petals; peripetalous fasciole present.
    - Peristome pentagonal, closed by 5 equal, triangular plates . . . PALAEOSTOMATIDAE
    - Peristome circular covered by a membrane, either naked or with few, scattered, small plates . . . . . AEROPSIDAE
  - Peristome more or less transversely elongated, with the primordial plate of interambulacrum 5 modified to form a more or less well-marked labrum.
    - Ambulacra flush, not petaloid or imperfectly so; fascioles wanting, or subanal and, in a few species, peripetalous, present . . . . PALAEOPNEUSTIDAE
    - Some or all of the ambulacra more or less sunken, or more or less petaloid, or both.
      - Subanal fasciole wanting . . . . . HEMIASTERIDAE
      - Subanal fasciole present . . . . . SPATANGIDAE

ECHINONEIDAE Wright.

This family includes but few Recent species. It is, however, very distinctly differentiated and its relationship to other Echini is quite obscure. Hawkins (1912. Proc. Zool. Soc. London, p. 490) considers the family most nearly allied to the Conulidae, having arisen with that family from some Pygaster-like form, and no better suggestion has been made. The discovery

of a well-developed lantern in very young individuals of Echinoneus reported by Mr. Agassiz in 1909 (Amer. Journ. Sci. ser. 4, **28**, p. 490) indicates a nearer relation to the Regular Echini than was suspected. The Recent members of the family have been so lately monographed by Westergren (1911. Mem. M. C. Z., **39**, no. 2, p. 35–68, pls. 1–31) that there is no occasion to discuss them further here. Only two genera are recognized and one of these is known from but a single specimen.

Key to the Genera of Echinoneidae.[1]

Poriferous areas depressed; all pore-pairs in peripodia . . . . . *Echinoneus.*
Poriferous areas flush with the surface of the test; pore-pairs of mid-zone without peripodia . . . . . *Micropetalon.*

Echinoneus.

Leske, 1778. Add. ad Klein, p. 7, 109.
Type, *Echinoneus cyclostomus* Leske, 1778. *Op. cit.*, p. 109.

The idea of dating Echinoneus from Van Phelsum, 1774, seems to me untenable, as pointed out in an earlier publication (1911. Ann. Mag. Nat. Hist., ser. 8, **7**, p. 596). Leske included two species in the genus but as the second is undoubtedly a synonym of the first, the latter is of course the type. In his discussion of the genus, Westergren (*op. cit.*) recognizes only a single species but he makes a casual reference (p. 44) to *E. abnormalis*, without committing himself as to the validity of that form. After the examination of seven specimens, I am still uncertain as to the status of *E. abnormalis*, but am inclined to consider it a valid species. In any case, Echinoneus is the only known genus of Echini in which so fundamental a character as the perforation of the tubercles is variable. The significance of such variability is not clear but it may indicate that the genus arose at about the time when the groups of Regular Echini with imperforate tubercles were being differentiated and before the character was fixed. The pedicellariae too indicate that Echinoneus is not a highly specialized type. All four kinds of pedicellariae are present; the globiferous are of a very primitive form not widely different from the tridentate and the same is true of the ophicephalous. Westergren has figured the pedicellariae, as well as all other morphological details, so elaborately and so accurately, that it would be quite superfluous to discuss them here.

[1] In this and all subsequent keys only Recent forms are considered.

After examining more than three hundred specimens, from the West Indies and the Indo-Pacific region, I can confirm Westergren's opinion that they all belong to a single species. I have collected living specimens in Torres Strait and am unable to detect any character whatever to distinguish them from those I have collected alive in Jamaica and Tobago.[1] On the other hand a certain specimen which de Loriol received from Mauritius and some received from Hawaii are obviously different. I therefore recognize two species, but *semilunaris* is not one of them.

Key to the Species of Echinoneus.

Color whitish or yellowish with a more or less marked reddish tinge; primary tubercles imperforate . . . . . *cyclostomus.*
Color more or less olive or greenish; primary tubercles perforate . . . . . *abnormalis.*

Echinoneus cyclostomus.

Leske, 1778. Add. ad Klein, p. 109.

Although this widely distributed species is exceedingly variable in the form of the test it is remarkably uniform in coloration. Living specimens are distinctly reddish, usually pale and only rarely dark enough in life to be called red, while the tube-feet are very bright red. Museum specimens, both alcoholic and dry, are usually deep brownish red if in good condition but they are often pale brown with no indication of red. In the West Indian region, this species is known from as far north as Bermuda and as far south as Tobago. It is not definitely known from the eastern Atlantic. In the Indo-Pacific region, it ranges from Zanzibar to Easter Island and Hawaii. The largest recorded specimen is 42 mm. long.

The ALBATROSS collected specimens at the following stations.

Paumotu Islands: Fakarava, Oct. 12, 1899; Makemo, Oct. 21, 1899.

Easter Island, Dec. 1904.

Twenty-five specimens (mostly bare and broken).

Echinoneus abnormalis.

De Loriol, 1883. Mem. Soc. Phys. Hist. Nat. Genève, **28**, no. 8, p. 41.

Although de Loriol had but a single specimen of this remarkable Echinoneus, his figures and description leave little to be desired. Since 1883, there

[1] Westergren (p. 48) refers to a difference between West Indian and Pacific specimens in the plating of the periproct, but this difference I do not find to be constant.

are no published records of the species having been met with and it is therefore of interest to record that there are now in the M. C. Z. collection seven specimens. Five are bare tests, four from the Hawaiian and one from the Society Islands. Three of those from Hawaii were presented by Mr. D. Thaanum in 1913. On my writing Mr. Thaanum of the peculiar interest attaching to these specimens and urging him to look out for the living animal, he promised to make every effort to find it. At last in July, 1916, two specimens were secured "from the sand, under coral rocks" on the beach near Hilo. Mr. Thaanum writes: "The color I should call light olive while living, now darkened and changed." The tube-feet, he notes, were "brownish-red." These two specimens, beautifully preserved (dry) make up the seven in the M. C. Z.

Compared with specimens of *cyclostomus* of their own size, these Hawaiian specimens are not strikingly different in color but the difference in the spinulation and tuberculation is most marked. The primary spines and tubercles are very small but the perforation of the latter is perfectly distinct. De Loriol's holotype was olive-green and was 52 mm. long by 45 mm. wide. The largest of our Hawaiian specimens is 31 × 24 mm. It is worthy of note that both species of Echinoneus were sent to de Loriol from Mauritius and we have both species from the Society Islands and from Hawaii. Yet all the specimens which Mr. Thaanum has collected near Hilo have proved to be *abnormalis*.

Micropetalon.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 251.

Type, *Micropetalon purpureum* A. Agassiz and Clark, 1907. *Loc. cit.*

Westergren (*op. cit.*) has so fully described and beautifully figured all the details of the unique holotype of the only known species of this genus, that it would be quite superfluous to add anything here. The specimen referred to was taken by the ALBATROSS.

Station 3847. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands, 23–24 fms. S., st.

NUCLEOLITIDAE Gregory.

Although Hawkins (1911. Geol. Mag., n. s., decade 5, **8**, p. 265) considers this family diphyletic, the Recent species seem to form a very homogeneous group and I therefore retain here the single family but without its long-familiar name Cassidulidae, which must be abandoned since Cassidulus is

preoccupied. When a complete revision of all the known forms, both living and fossil is made, it is probable that a more natural grouping, in accordance with some of Hawkins' suggestions, will be possible. Most of the living genera have the periproct in a more or less marked depression above the ambitus, but the most highly specialized forms have it distinctly on the oral surface. The number of genital pores is probably 4 in mature specimens, and, except in Neolampas, the individuals described as having only 2 or 3 such pores were probably not fully adult. The pedicellariae are in no way distinctive but tridentate, ophicephalous, and triphyllous occur in greater or less abundance, though often one or the other of these forms seems to be lacking. As a rule the pedicellariae are exceedingly small, and the triphyllous in particular are hard to find. The miliary spines remind one of those found in the Laganidae, as they usually have a more or less multiscalariform structure as in that family.

The Recent species of this family are not numerous but their proper grouping in genera has caused some difficulty, in part due to the attempt to refer certain species to genera based upon Fossil forms. This is well illustrated by the species referred to Catopygus by A. Agassiz and by Studer. Duncan recognized the fact that neither is strictly congeneric with the fossil forms of that genus but in attempting to establish a subgenus (Studeria) for their benefit, he unfortunately makes mention only of Laube's Tertiary *C. elegans*. Hence that species necessarily becomes the type of Studeria. Now a careful comparison of *C. elegans* with Agassiz's and with Studer's species shows that it is not congeneric with either. For Agassiz's *Catopygus recens*, I therefore propose the generic name Hypselolampas (see p. 109). Studer's *C. loveni* is not closely allied to *H. recens*, as it has no visible petals and the periproct is different. Judging from the published figures it seems to be a Neolampas and I venture, without having seen a specimen, to refer it to that genus.

Bell's *Nucleolites occidentalis* has also given rise to some difficulties. As Bell does not compare his specimen with Lamarck's *Cassidulus caribearum* and indeed does not mention that species or even the genus, it is not strange that the fact has been hitherto overlooked that Bell's species is identical with Lamarck's! Duncan established the subgenus Oligopodia for the Recent species of Nucleolites but Hamann on accepting it as a genus restricted it to the single species *O. epigonus*, leaving Bell's species and *recens* Milne Edwards in Nucleolites. As already stated Bell's species is not a Nucleolites at all (see below under Rhyncholampas) while *recens* seems to me too near to *epigonus* to be placed in a separate genus.

The genera Palaeolampas, Echinolampas, and Conolampas have been the cause of much discussion. Doubt has been cast on the validity of Conolampas but it is a well-marked group. On the other hand, I have not been able to draw a satisfactory line between Palaeolampas and Echinolampas and have therefore abandoned the former genus. The genera which seem to be valid for Recent Nucleolitidae may be distinguished as follows.

Key to the Genera of Nucleolitidae.

Periproct in a more or less evident depression or groove, usually above ambitus.
- Apical portion of test not modified to form a sunken brood-pouch.
  - Ambulacra more or less petaloid aborally.
    - Transverse diameter of periproct distinctly greater than longitudinal . *Rhyncholampas.*
    - Transverse diameter of periproct not greater than longitudinal.
      - Vertical diameter (*v. d.*) of test half horizontal diameter (*h. d.*) or less; periproct longer than wide . . . . . *Oligopodia.*
      - V. d. three fourths h. d. or more; periproct more or less circular . *Hypselolampas.*
  - Ambulacra not at all petaloid.
    - Periproct well above ambitus in a deep furrow . . . . . *Aphanopora.*
    - Periproct at or below ambitus in a slight depression or somewhat overhung by test . . . . . *Neolampas.*
- Apical portion of test modified to form a sunken brood-pouch . . . . . *Anochanus.*

Periproct at or below ambitus, not in a groove or depression but flush with surface of test.
- Longitudinal diameter of test greater than transverse; mouth anterior; anterior ambulacrum abactinally generally quite different from the others . . . . *Echinolampas.*
- Longitudinal diameter of test scarcely exceeds transverse, so ambitus appears circular; mouth central or slightly posterior; anterior ambulacrum not distinguishable from the others abactinally . . . . . *Conolampas.*

Rhyncholampas.

A. Agassiz, 1869. Bull. M. C. Z., 1, p. 270.

Type, *Cassidulus caribocarum* Lamarck, 1801. Syst. Anim. sans Vert., p. 349.

Not long after establishing this genus, Mr. Agassiz abandoned it (1873. Rev. Ech., pt. 3, p. 553) on the ground that "D'Orbigny established the genus Rhynchopygus for Cassidulus guadeloupensis, a tertiary fossil from Guadeloupe, which is probably identical with the species now living in the West Indies and Straits of Florida." As this living species had been virtually designated by Mr. Agassiz the type of Rhyncholampas, he naturally regarded his proposed genus as a synonym of D'Orbigny's. But the fact is, as stated by Mr. Agassiz in 1869, D'Orbigny did *not* establish Rhynchopygus for *Cassidulus guadeloupensis* but for

Nucleolites marmini Desmoulins. He distinctly says that "perhaps" *guadeloupensis* is congeneric. The two Recent species of Rhyncholampas differ from *N. marmini* in such essential particulars that I cannot consider them congeneric therewith. Hence it is necessary to restore Mr. Agassiz's generic name.

Nothing has hitherto been known in regard to the pedicellariae of the genus. They are not abundant and seem to be wholly wanting on the oral surface. Both tridentate and ophicephalous occur; the former are peculiar and might perhaps be considered as rostrate or as a simple form of globiferous; the ophicephalous closely resemble those of certain clypeastroids, notably Echinodiscus. The miliary spines are very peculiar in having successive swellings near tip; there may be two, three, or four of these enlargements (Pl. 144, fig. *1*). There seem to be no calcareous particles in the tube-feet.

Key to the Species of Rhyncholampas.

Unicolor; median actinal area deeply pitted and sculptured . . . . . *caribocarum.*
Spotted; median actinal area with shallow pits and little or no sculpturing . . . *pacifica.*

Rhyncholampas caribocarum.

Cassidulus caribocarum Lamarck, 1801. Syst. Anim. sans Vert., p. 349.
Rhyncholampas caribbaearum A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 270.

Plate 144, figs. *6*, *7*.

Both tridentate and ophicephalous pedicellariae are found but they occur only sparingly. The tridentate (rostrate?) have the valves rather delicate, from .16 to .48 mm. in length, the width of the base about half the length of the valve. These pedicellariae have considerable mesh-work at the back of the valves, with indications of a chamber similar to that in many globiferous pedicellariae, but there is no evidence of poison-glands. The tip of the blade (Pl. 144, fig. *7*) is provided with long sharp teeth, longest at the middle of the margin, in contrast to the condition in *R. pacifica*. The base of the valve has a low loop as in ophicephalous pedicellariae. Except for their less robust appearance, these tridentate pedicellariae differ little from those of *R. pacifica*. The ophicephalous pedicellariae have valves (Pl. 144, fig. *6*) only about .10 mm. long, though the loop adds from .03 to .08 more; they are quite similar to those of *Echinodiscus tenuissimus*. The miliary spines are not essentially different from those of *R. pacifica*.

Rhyncholampas pacifica.

Pygorhynchus pacificus A. Agassiz, 1863. Bull. M. C. Z., **1**, p. 27.
Rhyncholampas pacificus A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 270.

Plate 144, figs. *1–5*.

Only tridentate (rostrate) pedicellariae were found, though several fine specimens were examined, but these show considerable range in size. The large ones (Pl. 144, fig. *2*) have valves (Pl. 144, fig. *3*) half a millimeter long or more with the squarish base about half that in width; these valves are stout with much calcareous mesh-work within and the blade has a strongly dentate margin (Pl. 144, fig. *4*), the teeth on the sides being longer than those at the tip. The smaller pedicellariae have the valves (Pl. 144, fig. *5*) flatter, with much less mesh-work; they look more like ordinary tridentate pedicellariae. The smallest have valves only about .15 mm. long. The miliary spines (Pl. 144, fig. *1*) are notable for the peculiar series of 2–4 swellings, followed by distinct constrictions near the tip.

The Albatross brought home a single, small, dry specimen.

Station 2995. Near Revillagigedo Islands. Bott. temp. 68.4°. 31 fms. Gy. s., brk. co.

Oligopodia.

Duncan, 1889. Journ. Linn. Soc. Zool., **23**, p. 176.
Type, *Nucleolites epigonus* v. Martens, 1865. Monatsb. Berlin Akad., Wiss., p. 143.

Duncan proposed Oligopodia as a subgenus for the Recent species of Echinobrissus although he mentions no species by name under the heading. Hamann (1904. Bronn's Thier-reichs, **2**, abt. 3, p. 1386) however, on elevating the group to the rank of a genus limited it to *epigonus* alone, leaving *Nucleolites recens* Milne Edwards and *N. occidentalis* Bell (= *Rhyncholampas caribocarum*, as already pointed out) in Nucleolites. In my judgment, *N. recens* is congeneric with *epigonus* and both are quite different from typical Nucleolites of Lamarck. The latter name must be used in preference to the more familiar *Echinobrissus* as the latter is a pre-Linnaean name first revived by Gray in 1825.

De Meijere examined the pedicellariae of *O. epigonus* but his description is very brief and not very lucid. Three kinds of pedicellariae occur but they are minute and infrequent, and hence hard to find. The tridentate and

ophicephalous offer some tangible specific characters. The miliary spines are rather solid and slightly swollen at the tip but they retain their multiscalariform character fairly well.

Key to the Species of Oligopodia.

Periproct distinctly dorsal; long diameter of mouth transverse . . . . . *recens.*
Periproct distinctly posterior; long diameter of mouth longitudinal . . . . . *epigonus.*

Oligopodia recens.

Nucleolites recens Milne Edwards, 1836. Cuvier's Regne Animal. Illus. Ed., Zoöphytes, pl. 14, fig. 3.
Echinobrissus recens A. Ag. et auct.

Plate 144, figs. *8–11.*

This is one of the characteristic echinoderms of New Zealand. It has been reported also from Madagascar and from Australian Tertiary rocks but these records need confirmation. The pedicellariae are very infrequent but all three kinds, tridentate, ophicephalous, and triphyllous are present. The tridentate have the valves (Pl. 144, fig. *8*) about .40 mm. long, with a somewhat flattened blade, the margin of the distal half of which is strongly toothed; there is a more or less imperfect loop on the base of each valve (Pl. 144, fig. *10*). The ophicephalous pedicellariae have the valves (Pl. 144, fig. *9*) about .18 mm. long with a loop .03–.08 mm. in addition; the margin of the blade is more or less serrate; there seems to be no cross-piece at the tip of the loop of the largest valve. The triphyllous pedicellariae are very hard to find; the valves (Pl. 144, fig. *11*) are wide and flat and only about .05 mm. long.

Oligopodia epigonus.

Nucleolites epigonus v. Martens, 1865. Monatsb. Berlin Akad. Wiss., p. 143.
Oligopodia epigonus Duncan, 1889. Journ. Linn. Soc. Zool., **23**, p. 177, foot-note.

Plate 144, figs. *12, 13.*

In von Martens's later publications he referred to this species as *Nucleolus epigonus* but it is perfectly clear that he did so because it seemed to him undesirable to use a generic name ending in *ites* for a living species, and not because he considered *epigonus* something other than a typical Nucleolites. The case is precisely the same as Cidaris and Cidarites (except that here the simple noun antedates the derivative) and these two names are universally regarded as

synonyms. Nucleolus is therefore a synonym of Nucleolites and does not invalidate Oligopodia.

The pedicellariae of this species were very briefly described by de Meijere (1904) but as he gives no figures, it has seemed desirable to illustrate them now. The valves of the tridentate (Pl. 144, fig. *12*) are narrower, deeper, and of more uniform width than those of *recens*, and have smooth margins; they are also much smaller, only about .20 mm. long. The ophicephalous valves (Pl. 144, fig. *13*) are relatively shorter and wider than those of *recens* and only measure about .10 mm. long with a loop, .02–.04 mm. long in addition; the tip of the largest loop on each head has a well-marked cross-piece. There are no loops on the valves of the tridentate pedicellariae. No triphyllous pedicellariae have been found as yet, but all the pedicellariae are very small and hard to find.

Hypselolampas,[1] gen. nov.

Type, *Catopygus recens* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 204.

The reasons for creating a new genus for this species are stated above (p. 104). As I have never seen a specimen I am unable to give any new information about the form.

Aphanopora.

De Meijere, 1902. Tijd. Ned. Dierk. Vereen, (2), **8**, p. 8.
Type, *Aphanopora echinobrissoides* de Meijere, 1902. *Loc. cit.*

This is another monotypic genus of which I have never seen a specimen and hence have nothing to add to the information given by the original describer.

Neolampas.

A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 271.
Type, *Neolampas rostellata* A. Agassiz, 1869. *Loc. cit.*

The reduction in number of genital pores which seems to characterize two of the three species in this genus is worthy of special note. Perhaps more abundant material may show that we are misled by immature specimens. Döderlein has figured tridentate and ophicephalous pedicellariae from one species of the genus, while de Meijere and I have found only ophicephalous. All the pedicellariae are very minute and resemble those of Oligopodia.

[1] ὑψηλός = high + λαμπάς = lantern, in reference to the shape of the test.

Key to the Species of Neolampas.

Mouth approximately central; genital pores 4 . . . . . *loveni.*
Mouth distinctly anterior.
Genital pores 3; periproct not distinctly wider than long . . . . . *rostellata.*
Genital pores 2; periproct distinctly wider than long . . . . . *tenera.*

Neolampas loveni.

Catopygus loveni Studer, 1880. Monatsb. Berlin Akad., Wiss., p. 878.

Nothing is known as to the pedicellariae of this species. Further material may show that it is not a Neolampas at all, but there is nothing in Studer's description to prevent its being placed here. The two original specimens were taken in 117 fms. south of the Cape of Good Hope.

Neolampas rostellata.

A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 271.

The miliary spines are like those of Oligopodia, with slightly swollen, rather solid tips. Döderlein's figure of one (1906. VALDIVIA Ech., pl. 48, fig. 9g) is rather indistinct but his figures of the pedicellariae (figs. 9 a-f) are satisfactory. On the specimens examined I could find only ophicephalous pedicellariae but they were fairly common. The valves are only about .06–.08 mm. long, aside from the moderately developed loop.

Neolampas tenera.

De Meijere, 1902. Tijd. Ned. Dierk. Vereen, (2), **8**, p. 8.

According to de Meijere's crude figure (1904. SIBOGA Ech., pl. 19, fig. 389) the valves of the ophicephalous pedicellariae of this East Indian species must be very different from those of *rostellata.* No tridentate pedicellariae were found.

Anochanus.

Grube, 1868. Monatsb. Akad. Berlin, p. 178.
Type, *Anochanus sinensis* Grube, 1868. *Loc. cit.*

This is another monotypic genus of which very little is known for Grube never published his promised monograph on it, and no one has since met with the species.

Echinolampas.

Gray, 1825. Ann. Phil., **26**, p. 429.

Type, *Echinanthus ovatus* Leske, 1778. Add. ad Klein, p. 127.

This is the only genus of the family which has a sufficient representation in the seas of today to make it well known. There are numerous Fossil forms and at least eight Recent forms have been named besides three species of Palaeolampas which seem properly congeneric.

Nothing has been published hitherto concerning the pedicellariae of the genus except by A. Agassiz and de Meijere. Mr. Agassiz gives (1881. CHALLENGER, Ech., pl. 43, figs. 3–5) two figures of ophicephalous pedicellariae and one of the head of a tridentate of *Echinolampas oviformis* (= *E. ovata*) but there is no detailed description. De Meijere gives (1904, SIBOGA Ech., pl. 19, figs. 381–383) some sketches of tridentate and triphyllous valves, from specimens of Echinolampas taken by the Siboga near Saleyer, D. E. I., which he identified as *depressa*. While satisfied that his specimens are not the West Indian *depressa*, I am not sure what they are; it is quite probable that they represent an undescribed species. I have examined the pedicellariae of five species but in only one is there a strikingly characteristic form. The three kinds, tridentate, ophicephalous, and triphyllous, are very generally present but in some species one or two kinds may be lacking. The triphyllous are of course the most easily overlooked because of their minute size. The tridentate may occur in two quite different forms, one with narrow, the other with wider blades. The miliary spines are a little swollen at the tip, and are usually smooth but in *sternopetala* are distinctly prickly.

The species of Echinolampas are very hard to distinguish from each other, and as a result there is much confusion about the Recent forms. The species longest and best known was described by Leske as *Echinanthus ovatus*. Gmelin changed the specific name to *oviformis* and this change was accepted by Lamarck, Gray, Agassiz, and later writers. There seems to be no good reason, however, why *ovatus* should not be restored to its proper usage, as Döderlein suggested in 1906. In 1837 Desmoulins described a new living species from West Africa as *E. richardi*. Mr. Agassiz replaced this name by *hellei* on the ground that *richardi* Desmoulins was not the same as *richardi* Desmarest. But Desmarest's name has no validity and even if it had, *richardi* Desmoulins has priority, and I have therefore accepted it. In 1857, Gray described the West

Indian species, *depressa* and in 1876, de Loriol described the Mauritian form, *alexandri*. In 1880, Bell described the South African species, *crassa*, for which he instituted Palaeolampas, a genus I am not prepared to accept. Cotteau, in 1889, based a new species, *blanchardi*, on a small specimen from West Africa; he discusses it with reference to *depressa* and *alexandri* but makes no mention of *ovata* or *richardi;* I see no reason to doubt it was a young *richardi*. In 1893, Alcock described a species from India, which he called *castanea;* unfortunately he gives no measurements but I can find no valid character in his description by which to distinguish it from *ovata*. In 1905, Döderlein described two species, *chuni* and *sumatrana*, taken by the VALDIVIA, and related so nearly to *crassa* that he called them Palaeolampas. The material was scanty and imperfect and the status of the two species is still debatable.

The primary character by which the species are to be distinguished is the relative length of the various poriferous areas, but as this is affected by growth-changes and subject to more or less individual variation, it has to be used with caution. The shape of the test is a similarly useful character, but of variable value, while the tuberculation of the test is rather more reliable. The distance separating the pore-pairs in an area from each other, and the distance between the two pores of a pair are factors to be considered. But little weight can be given to color and only in few cases do the pedicellariae prove of distinctive value.

Key to the Species of Echinolampas.

Poriferous areas abactinally, long, reaching nearly or quite to ambitus (at least in posterior areas of ambulacra II and IV), with little or no tendency to form petals.

Test nearly as wide as long; ambulacra rather wide (half way between apex and ambitus, ambulacrum II is more than ⅓ of interambulacrum 2, at same level); median area of II with 6 or more vertical series of primary tubercles.

Test not gibbous posteriorly; anterior poriferous areas of ambulacra II and IV, only 4–10 pore-pairs shorter than posterior . . . . . *crassa.*

Test somewhat gibbous posteriorly; anterior poriferous areas of II and IV, 17–20 pore-pairs shorter than posterior . . . . . *sumatrana.*

Test not nearly as wide as long (width .80–.86 of length); ambulacra narrow (II not over ⅓ of 2); median area of II with only 3–4 vertical series of primary tubercles . . . . . *chuni.*

Poriferous areas abactinally more or less shortened, not reaching nearly to ambitus, often distinctly petaloid.

Ambulacra moderately wide, more or less petaloid abactinally; inner poriferous areas of ambulacra I and V much more than half as long as outer.

Tuberculation of test close and fine; median area of II and IV with 9–14 vertical series of tubercles.
Test elevated (v. d. = .52–.67 h. d.); poriferous areas of I and V markedly unequal, the outer longer . . . . . *ovata.*
Test depressed (v. d. = .47–.53 h. d.); poriferous areas of I and V more or less equal or the inner longer . . . . . *richardi.*
Tuberculation coarser; median area of II and IV with only 4–8 vertical series of primary tubercles . . . . . *alexandri.*
Ambulacra narrow, little or not at all petaloid; inner poriferous areas of I and V about half as long as outer or even less.
Pore-pairs vertically closer than the pores of a pair are to each other horizontally; tuberculation rather fine (unpaired petal having left-hand poriferous area 10 mm. long, includes about 30 primary tubercles) . . *depressa.*
Pore-pairs vertically farther apart than pores of a pair are horizontally; tuberculation coarser (unpaired petal having left-hand poriferous area 10 mm. long, includes only about 15 primary tubercles . . . . . *sternopetala.*

Echinolampas crassa.

Palaeolampas crassa Bell, 1880. Proc. Zool. Soc. London, p. 43.

Plate 144, fig. *17.*

Examination of one of Bell's cotypes, reveals only tridentate pedicellariae, but they are common. The valves (Pl. 144, fig. *17*) are intermediate in form between those of *alexandri* and *depressa*, and range in length from .22 to .45 mm.

Echinolampas sumatrana.

Palaeolampas sumatrana Döderlein, 1905. Zool. Anz., **28**, p. 624.

This species is known from only a single, imperfect bare test taken by the VALDIVIA in Siberut Strait, Sumatra, in 206 fms.

Echinolampas chuni.

Palaeolampas chuni Döderlein, 1905. Zool. Anz., **28**, p. 624.

This species is known from only two bare tests taken by the VALDIVIA at the same time and place with the preceding species.

Echinolampas ovata.

Echinanthus ovatus Leske, 1778. Add. ad Klein, p. 127.
Echinus oviformis Gmelin, 1788. Linné, Syst. Nat., ed. 13, **1**, pt. 6, p. 3187.
Echinolampas ovata Döderlein, 1906. Valdivia Ech., p. 240.

Plate 153, figs. *1*, *2*.

Owing to the confusion that has existed in the identification of the different forms of Echinolampas, the exact geographical distribution of this species is not known. India and Ceylon are the only places from which I have seen specimens but there is no reason to doubt the records from the Red Sea and from Molucca. The pedicellariae are few and insignificant. The ophicephalous are like those of *alexandri* while the triphyllous do not differ essentially from those of *sternopetala*. The tridentate seem to be of only one form, that with narrow, straight valves, figured under *alexandri* (Pl. 144, fig. *16*).

Echinolampas richardi.

Desmoulins, 1837. Tab. Syn., p. 340.

Plate 153, figs. *9*, *10*.

This species is known only from the West Coast of Africa and I have seen only a bare test. Much more material is necessary before the validity of the species can be considered established.

Echinolampas alexandri.

De Loriol, 1876. Mem. Soc. Phys. Hist. Nat. Genève, **24**, p. 660.

Plates 144, figs. *14–16*; 153, figs. *3*, *4*.

This species is known from both Ceylon and Mauritius but not nearly enough material is available to settle the question of its validity. It is very doubtful whether it is really distinct from *ovata*. I found no triphyllous pedicellariae in the specimens examined but ophicephalous were not rare; the valves (Pl. 144, fig. *15*) are about .20 mm. long besides the loop, which is .03–.08 mm. additional; the blade is quite rounded. Tridentate pedicellariae were found of two kinds which do not seem to intergrade. The valves in one (Pl. 144, fig. *14*) are somewhat curved and are flattened and widened at the tip for the portion which is in contact with its fellows; there are coarse teeth at the apex and a

distinct loop on the base. In the other, the valves (Pl. 144, fig. *16*) are straighter and narrower; they lack both teeth and loop. In both forms, the valves range from .25 to .40 mm. in length.

Echinolampas depressa.

Gray, 1851. Proc. Zool. Soc. London, p. 38.

Plates 144, figs. *18*, *19*; 153, fig. *8*.

This is the West Indian species of the genus and there is little reason to doubt that de Meijere's record of it from near Saleyer, Dutch East Indies, is a case of mistaken identification. Very likely the Siboga specimens represent an undescribed species. Ophicephalous and tridentate pedicellariae occur in *depressa* but no triphyllous were found. The ophicephalous have the valves (Pl. 144, fig. *19*) somewhat smaller than those of *alexandri* and the blade is less rounded. The tridentate are all of one kind with valves (Pl. 144, fig. *18*) .25–.45 mm. long, having the blade a little widened, flattened and serrate at tip.

Echinolampas sternopetala.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **51**, p. 130.

Plates 144, figs. *20–24*; 147, figs. *1*, *2*; 153, figs. *5–7*.

The available specimens measure 43–53 mm. in length, 36–44 mm. in breadth and 19–22 mm. in height. The breadth averages about .85 of the length and the height averages not quite .45 of the length. The abactinal portion of the ambulacrum is not at all petaloid and the part of the poriferous area having paired pores is not distinctly indicated. Indeed owing to the fact that the lateral margins of the ambulacra are strongly purple-tinted, a careful examination is necessary to determine the number of pore-pairs. In the holotype (Pl. 153, fig. *5*) ambulacrum III has 27 pore-pairs on the left-hand side and 30 on the right, while in a specimen very little smaller (Pl. 147, fig. *2*) there are only 12 on the left and 17 on the right. In the holotype, ambulacrum II has 27 pore-pairs on the left and 37 on the right, while the smaller specimen has 12 and 29 respectively, a remarkable disparity. In the holotype, ambulacrum I has 32 pore-pairs on the left and 25 on the right, while in the smaller specimens the figures are 24 and 12. The longer poriferous area in each of these three ambulacra are in the holotype 12, 15, and 15 mm. respectively

while in the smaller specimen they are only 5, 9, and 7 mm. These figures indicate a wide degree of individual diversity in the species. The pores of each pair are very near together while the successive pairs are rather far apart, so that the distance between two pores vertically is distinctly greater than that between two horizontally. As the pores are very small, the whole effect is a very narrow poriferous area, not easily made out (Pl. 153, fig. *5*).

The tuberculation of the test is rather scattered. Thus, there are only about 25 primary tubercles in an area 5 mm. square on the abactinal surface in an interradius while in *E. depressa* on a similar area there are about 50. Moreover in *depressa* the ridges between succeeding pore-pairs carry a single linear series of 3–5 miliary tubercles, but in *sternopetala* these are quite wanting.

The periproct (Pl. 147, fig. *1*) is obliquely placed at the posterior end of the test (Pl. 153, figs. *6* and *7*) but the degree of obliqueness shows great diversity. In the holotype, the angle formed by the plane of the periproct and that of the oral surface of the test is about 150° while in a second specimen it is only about 130°. As usual in the genus, the periproct is covered by three large plates, bearing both primary and miliary spines, and above these plates are a considerable number of minute plates surrounding the anus itself. The peristome is rounded-pentagonal, about 8 mm. wide by 5 mm. long; the most marked angle is in ambulacrum III. The peristomal membrane seems to be full of very minute calcareous plates, neither large enough nor sufficiently crowded to form a pavement.

The primary spines are smooth and terete, rather blunt, with about eight longitudinal ridges; orally they are 2–4 mm. long but on the aboral surface, they rarely exceed 1.5 mm. The miliary spines are about a millimeter long, multiscalariform (with about 6 or 7 rods); the tips are slightly swollen or expanded and the whole spine is more or less distinctly prickly, at least when cleaned of its organic matter.

Of pedicellariae, all three kinds occur but the triphyllous are few and hard to find. The valves of the triphyllous (Pl. 144, fig. *20*) are only .05 mm. long; they are quite flat with serrate margins. The ophicephalous pedicellariae are not rare; their valves (Pl. 144, fig. *21*) are about .21 mm. long with the loop .03–.07 mm. more, and have a low, wide mouth which is quite distinctive. The tridentate pedicellariae are very common and show great diversity in form of valves and in size. The small ones are not peculiar, and their valves (Pl. 144, fig. *24*) are only .20–.25 mm. long. The largest, with valves (Pl. 144, fig. *22*) over .60 mm., are very characteristic; the margins of the valves are coarsely

sinuate and more or less incurved. Between the smallest and largest forms, numerous intermediates are found, their margins (Pl. 144, fig. *23*) showing more or less marked sinuations.

This is beyond doubt the best defined species in the genus. The small size and inequality of the poriferous areas, the sparse tuberculation, and the remarkable tridentate pedicellariae form a notable combination of characters. In the poriferous areas and in the shape of the test it is nearest *depressa*, but the tuberculation and pedicellariae are quite different and the periproct is not so distinctly oral in position as in that species. The ALBATROSS took two specimens of *sternopetala* during its trip to Japan in 1900 and secured another (the holotype) during the voyage of 1906.

Station 3749. Off Suno Saki, Honshu Island, Japan. Bott. temp.? 83–158 fms. Bk. s., sh.

Station 4934. Off Kagoshima Gulf, Japan. Bott. temp. 60.6°–56°. 103–152 fms. St., rky.

Bathymetrical range, 83–158 fms.

Three specimens.

Conolampas.

A. Agassiz, 1883. BLAKE Ech., p. 48.

Type, *Conoclypus sigsbei* A. Agassiz, 1878. Bull. M. C. Z., **5**, p. 190.

Plate 144, figs. *25–32*.

The validity of this genus has been called in question but examination of the pedicellariae and spicules confirm the opinion that it is a well-marked, natural group. The almost circular ambitus, the five identical ambulacra, the equality of the poriferous areas extending to the ambitus, the conspicuous phyllodes and bourrelets about the central peristome, and the sharp angle formed by the oral surface and the sides of the test, which are nearly vertical at the ambitus, form a really significant combination of features. And to these may now be added a noteworthy arrangement of the plates around the peristome. Jackson (1912. Phylogeny Ech., p. 72) has pointed out that in *Lovenia forbesi* from the Australian Miocene, the primordial plates in interambulacra 1 and 4 are pushed out from the basicoronal row dorsally, so that the primordial ambulacrals I*b* and II*a*, and IV*b* and V*a* are in contact. In several spatangoid genera, besides Lovenia, interambulacra 1 and 4 are thus shut out (see pls. 148, fig. *8;* 150, fig. *5;* 151, fig. *7;* 152, fig. *3*). This same condition exists in

Conolampas, whereas in Echinolampas the primordial interambulacral plates are all in the basicoronal row.

Minor features of this interesting genus are the characteristic triphyllous pedicellariae and a notable arrangement of spicules in the tube-feet. These latter are perhaps only specific characters but as the genus is monotypic, they may properly be described here. Pedicellariae are quite common and three sorts occur but the ophicephalous are least frequent. The tridentate vary greatly in size but not in form. The valves (Pl. 144, figs. *30*, *31*) range from .08 to .72 mm. in length and are in contact only at or near the tip; in the larger ones the margins of the valves tend to become sinuate but are never very markedly so. The ophicephalous pedicellariae are much like those of *Echinolampas sternopetala* but are much larger; the valves (Pl. 144, figs. *26*, *27*) are about .30 mm. long with the loop .07–.13 mm. more. The triphyllous pedicellariae are quite odd; the valves (Pl. 144, figs. *28*, *29*) are only .07 mm. long but they are strongly curved and though convex on the back basally are concave distally; there is a large lumen through the apophysis.

The miliary spines are little or not at all swollen at the tip and are usually a little prickly. Sphaeridia are common and measure about .20 mm. in length (Pl. 144, fig. *25*). The calcareous particles or perforated plates in the tube-feet (Pl. 144, fig. *32*) are rather numerous but are not crowded; they are arranged in three longitudinal series, with their longer axis at right angles to the axis of the foot and their shorter axis at right angles to the surface of the foot; they are thus piled up one on another vertically.

URECHINIDAE Lambert.

This family and the three following, comprising the group of meridosternous spatangoids, has been so recently and so well discussed by Mortensen (1907. Ingolf Ech., pt. 2, p. 39–89) that there is little to add to his results. The material accessible in any or all of our museums is not sufficient to settle satisfactorily all the debatable points, and that which is at hand for my work leaves much to be desired. My work fully supports Mortensen's conclusions and I therefore shall only add the data secured on material which was not available to him. Whether the four families here recognized are really natural groups is still open to suspicion but it is at least a convenient arrangement and certainly not unnatural. There is no question that the Urechinidae are more primitive than the Pourtalesiidae but whether it is really the oldest group of

the four cannot yet be asserted. The families are distinguished from each other by the arrangement of the interambulacral plates about the mouth, and the position of that organ. Whether the pores are simple or in pairs is also given much weight but the simple condition may be a secondary character, not primitive, in some specialized forms.

In the Urechinidae itself, the position of the periproct, the form and character of the test and the relative size of the primordial interambulacral plates, serve to separate the genera. I agree with Mortensen that the characters supposed to separate Cystechinus from Urechinus are vague and unsatisfactory and have abandoned the attempt to maintain the former genus. The pedicellariae are plentiful and notably diversified in the Urechinidae, true globiferous, rostrate, tridentate, ophicephalous, and triphyllous all occurring in more or less variety of form. The globiferous may intergrade with the rostrate and some forms of the latter are so much like tridentate that it is only a matter of opinion which they shall be called. Both primary and miliary spines are more or less prickly and the latter are swollen or expanded at the tip. Such calcareous spicules as occur in the tube-feet are simple, knobbed, or slightly branched rods.

Key to the Genera of Urechinidae.

Periproct in a depression above ambitus . . . . . *Plexechinus.*
Periproct at or below ambitus, not in a marked depression.
  Test moderately high (v. d. = .50–.70 length), not flexible; plates around mouth of moderate size; primordial interambulacrals much bigger than buccal plates . . . . . *Urechinus.*
  Test very high (v. d. = .70–.90 length), thin and flexible; plates around mouth very small; primordial interambulacrals no larger than some buccal plates; globiferous pedicellariae have blade ending in a single hook . . . . . *Pilematechinus.*

Plexechinus.

A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 76.

Type, *Plexechinus cinctus* A. Agassiz, 1898. *Loc. cit.*

This genus includes certain small urechinids from cold water in widely separated regions. The largest known specimens are less than an inch long but seem to be adult.

Key to the Species of Plexechinus.

Genital pores 4, in 4 separate plates; subanal fasciole includes 3 pairs of interambulacral plates . . . . . *nordenskiöldi.*
Genital pores 2, minute in a single plate; subanal fasciole includes 4 pairs of interambulacral plates.

Anal snout not very prominent; greatest height of test far back; labrum usually in contact with following interambulacral plate . . . . . *hirsutus.*
Anal snout very prominent; greatest height of test just back of middle; labrum separated by ambulacral plates from following interambulacral . . . . . *cinctus.*

Plexechinus nordenskiöldi.

Mortenson, 1905. Vid. Med. f. 1905, p. 242.

This Antarctic species was taken at the very moderate depth of 89 fms. by the Swedish South Polar Expedition and has been fully described by Mortensen in his report on the Echini of that Expedition.

Plexechinus hirsutus.

Mortensen, 1905. Vid. Med. f. 1905, p. 242.

This Arctic species was taken by the INGOLF at depths ranging from 485 to 1300 fms. It is much nearer the following species than it is to the preceding.

Plexechinus cinctus.

A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 76.

Plate 145, figs. *3–6.*

This is the tropical species of the genus and was taken by the ALBATROSS in the Gulf of California at a depth of 676 fms. The pedicellariae are more like those of *hirsutus* than they are like those of the Antarctic species, but the tridentate are very characteristic. These have valves (Pl. 145, fig. *6*) about .66 mm. long, with the blade narrow, somewhat compressed and coarsely dentate at tip. The ophicephalous have valves (Pl. 153, fig. *3*) only about .12 mm. including the loop. The rostrate (or globiferous, as Mortensen calls them) are very similar to those of *hirsutus;* the valves (Pl. 153, figs. *4*, *5*) are only about .16 mm. long, and the base is nearly that in width.

Urechinus.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 207.

Type, *Urechinus naresianus* A. Agassiz, 1879. *Loc. cit.*

Since the first description of these notable sea-urchins, some eight additional species have been added to the genus and the distinctions by which they

were supposed to be separated from each other have become increasingly vague. Mortensen's admirable study of the genus (1907. INGOLF Ech., pt. 2, p. 39–53) threw a great deal of light on the group, but it is still a matter of no little uncertainty how many really valid species there are. The form of the test shows extraordinary diversity even in a single species and practically no reliance can be placed on it for systematic purposes. Color is also variable and the tuberculation of the test, the number of spines and the pedicellariae are not to be trusted. Even the position of the periproct is not a reliable character. In the key given herewith the character of the globiferous pedicellariae, which seem to be very constant, and the number of genital pores, a character whose value is still undetermined, are exclusively used. In this way seven of the nine species hitherto described can be distinguished, but I am obliged to consider the proposed species *Cystechinus purpureus* A. Agassiz and Clark identical with *loveni* and *Urechinus fragilis* Koehler identical with *wyvillii*. It is a little odd that Mr. Agassiz and I compared our specimens with *wyvillii* and not with *loveni*, while Koehler does not compare his species with *wyvillii*.

The pedicellariae in this genus are very diversified, but the most characteristic form, the globiferous, are unfortunately often very few and far between. The ophicephalous are often exceedingly abundant but are not at all distinctive of either genus or species. Mortensen's figures of an ophicephalous pedicellaria (1907. INGOLF Ech., pt. 2, pl. ix, figs. 7, 10) supposed to be that of *Cystechinus clypeatus* seem conclusive proof that the fragments on which such were found were not the remains of an urechinid. Mortensen himself suggests this but in my opinion there can be no question about it, unless the pedicellaria was accidentally associated with the fragments. The tridentate pedicellariae in Urechinus are numerous and diversified and frequently quite distinctive; certain forms designated by Mortensen as "coarse tridentate" seem better called rostrate even though their intergradation with ordinary tridentate can sometimes be traced. The triphyllous pedicellariae are minute and rather infrequent. The sphaeridia are notable for being quite rough or even prickly.

Key to the Species of Urechinus.

Globiferous pedicellariae with only a single terminal point.
- Genital pores 4; blade of globiferous pedicellariae curved inward but not bent . *clypeatus.*
- Genital pores 3; blade of globiferous pedicellariae distinctly bent inwards . . *drygalskii.*

Globiferous pedicellariae with 2 or more teeth around the terminal opening.
- Globiferous pedicellariae with the terminal opening having the lower margin with 4–6 long slender teeth, the upper with none . . . . . *reticulatus.*

Globiferous pedicellariae not as above.
Genital pores 4.
Globiferous pedicellariae small with short tubular blade and 1 tooth on each side of terminal opening . . . . . *wyvillii.*
Globiferous pedicellariae with stout tubular blade and 1–3 slender teeth on each side of terminal opening . . . . . *giganteus.*
Genital pores 3.
Globiferous pedicellariae with the large terminal opening surrounded by about 7 long slender teeth . . . . . *naresianus.*
Globiferous pedicellariae small with 2 (or 1?) teeth on each side of terminal opening . . . . . *loveni.*

Urechinus clypeatus.

Cystechinus clypeatus A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 208.

Mortensen has shown that two quite distinct species were included under this name in the CHALLENGER report. The true urechinid is the "thin-plated" form from the southern Atlantic. The "thick-plated" form from the China Sea is not identifiable but is probably one of the Pourtalesiidae.

Urechinus drygalskii.

Mortensen, 1905. Vid. Med. f. 1905, p. 241.

This species is known only from the holotype taken in the Antarctic deep sea by the German South Polar Expedition, 1901–03.

Urechinus reticulatus.

H. L. Clark, 1913. Bull. Amer. Mus. Nat. Hist., **32**, p. 224.

This species is also known only from the holotype, which was taken by the ALBATROSS in 879 fms. off Lower California.

Urechinus wyvillii.

Cystechinus wyvillii A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 208.
Urechinus wyvillii Mortensen, 1907. INGOLF Ech., pt. 2, p. 50.

This is an Antarctic species taken by the CHALLENGER at great depths ranging from 1375 to 2160 fms.

Urechinus giganteus.

A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 79.

This is the largest species of the genus and was taken by the ALBATROSS in the Gulf of California in 995 fms.

Urechinus naresianus.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 207.

This species seems to be cosmopolitan in its distribution and is much the best known species of the genus. The great diversity in the form of the test is one of its most striking features. The ALBATROSS material adds nothing of importance to our previous knowledge of the species.

Station 4766. Between Atka Island and Bowers Bank, Bering Sea. Bott. temp.? 1766 fms. Bott.?

Station 5030. In Okhotsk Sea. Bott. temp.? 1800 fms. Br. m. Thirteen specimens.

Urechinus loveni.

Cystechinus loveni A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 79.
Urechinus loveni Mortensen, 1907. INGOLF Ech., pt. 2, p. 50.

Plate 147, fig. *3*.

After a careful examination of both test and pedicellariae I am forced to the conclusion that the ALBATROSS specimens, which Mr. Agassiz and I referred to a new species, *Cystechinus purpureus*, should really be regarded as *loveni*. Mortensen has described and figured admirably the pedicellariae of the latter. All of the globiferous pedicellariae found in the ALBATROSS material have *two* teeth on each side of the terminal opening. One of the specimens from Station 5030 is notable for having *four* genital pores but the extra one is in genital 1 close beside the normal pore of that plate (see Pl. 147, fig. *3*). The original specimens of *loveni* were taken off Acapulco, Mexico, in 1879 fms. Those of the present series are from the same bathymetrical region but from much further north; several are completely crushed.

Station 4761. South of the Shumagin Islands, Alaska. Bott. temp. 35°. 1973 fms. Bl. clay.

Station 4766. Between Atka Island and Bowers Bank, Bering Sea. Bott. temp.? 1766 fms. Bott.?

Station 5030. In Okhotsk Seas. Bott. temp.? 1800 fms. Br. M.

Bathymetrical range, 1766–1973 fms.

Ten specimens.

Pilematechinus.

A. Agassiz, 1904. Mem. M. C. Z., **31**, p. 165.
Type, *Cystechinus rathbuni* A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 79.

This genus has been as exhaustively studied by Agassiz and by Mortensen as the nature of the available material would permit, so there is nothing new to be added.

Key to the Species of Pilematechinus.

Genital pores 4; lower margin of periproct some distance above ambitus . . . . . *rathbuni.*
Genital pores 3; lower margin of periproct just above ambitus . . . . . *vescica.*

Pilematechinus rathbuni.

Cystechinus rathbuni A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 79.
Pilematechinus rathbuni A. Agassiz, 1904. Mem. M. C. Z., **31**, p. 165.

This is the Panamic species taken at 1672–1823 fms. by the ALBATROSS.

Pilematechinus vescica.

Cystechinus vescica A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 209.
Pilematechinus vescica A. Agassiz, 1904. Mem. M. C. Z., **31**, p. 232.

This species was taken by the CHALLENGER between Juan Fernandez and Chile at the remarkable depth of 2225 fms., over 2.5 miles.

ECHINOCORYTHIDAE Gregory.

This family includes but a single Recent genus and species. I have had no opportunity of examining a specimen, so simply follow de Meijere and Mortensen in placing it in this family.

Stereopneustes.

De Meijere, 1902. Tijd. Ned. Dierk. Vereen, (2), **8**, p. 9.
Type, *Stereopneustes relictus* de Meijere, 1902. *Loc. cit.*

This genus cannot be placed in the Urechinidae because of the structure of interambulacra 2 and 4, in which the primordial plate is followed by a pair of plates, instead of by one. In this respect it agrees with many nearly allied

fossil forms and is accordingly placed in the Echinocorythidae with them. There is only a single species known, three specimens of which were taken by the SIBOGA at two widely separated stations in the East Indies at depths of 290–460 fms.

CALYMNIDAE Mortensen.

This family was proposed for the single genus Calymne. It differs from the proceeding only in having all the ambulacral pores simple.

Calymne.

Wyville Thomson, 1877. Voy. Challenger. The Atlantic, **1**, p. 397.
Type, *Calymne relicta* Wyville Thomson, 1877. *Loc. cit.*

This genus and species is based on a single fragmentary specimen collected by the Challenger near the Azores Islands at the extraordinary depth of 2650 fms. Until more material is secured, the genus is most easily provided for by giving it a family of its own.

POURTALESIIDAE Lovén.

This is undoubtedly the most remarkable and the most specialized family of Echini. As it has been very extensively studied by Lovén, A. Agassiz, and Mortensen, there is very little to add to our knowledge of it, particularly as the only material available, not already worked over by Mr. Agassiz, consists of a single species of Pourtalesia. The pedicellariae in the family are notable and oftentimes characteristic. The ophicephalous in particular are of a type peculiar to this family and quite unlike those occurring among other Echini. The various forms have been fully described and figured by Mortensen. The following key to the genera is compiled from Mortensen's work, and much of the material in the keys to species is from the same source.

Key to the Genera of Pourtalesiidae.

No subanal rostrum present.
- Tube-feet near mouth penicillate; a fasciole present on oral surface; test more or less hemispheric or ovoid . . . . . *Sternopatagus.*
- Tube-feet near mouth not modified; no fascioles; test not hemispheric or ovoid.
  - Apical system compact; test widest anteriorly . . . . . *Echinocrepis.*
  - Apical system disjunct; test not widest anteriorly . . . . . *Cystocrepis.*

Subanal rostrum more or less well developed.
- Subanal rostrum small, overhung by test; no subanal fasciole . . . . . *Spatagocystis.*
- Subanal rostrum conspicuous, not overhung by test; subanal fasciole present.
  - Test stout, not greatly elongated; dorsal plates of interambulacrum 5 alternating; often 2 pores in plates I*a*1 and V*b*1
    - Test widest anteriorly; 1 or 2 pores in I*a*1 and V*b*1. . . . . *Ceratophysa.*
    - Test not widest anteriorly; only 1 pore in I*a*1 and V*b*1 . . . . . *Helgocystis.*
  - Test not stout, more or less elongated; dorsal plates of interambulacrum 5, paired; only 1 pore in I*a*1 and V*b*1.
    - Bivial ambulacra discontinuous; test not excessively elongated . . . *Pourtalesia.*
    - Bivial ambulacra continuous; test excessively elongated . . . . . *Echinosigra.*

Sternopatagus.

De Meijere, 1902. Tidj. Ned. Dierk. Vereen, (2), **8**, p. 10.

Type, *Sternopatagus sibogae* de Meijere, 1902. *Loc. cit.*

The SIBOGA took a single specimen of this interesting form south of Timor in 1139 fms. No other specimens have since been met with.

Echinocrepis.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.

Type, *Echinocrepis cuneata* A. Agassiz, 1879. *Loc. cit.*

Like most of the genera in this family, Echinocrepis is monotypic and our knowledge of the species is limited to very scanty material. Two specimens were taken by the CHALLENGER in 1610 fms. near the Crozet Islands, but one of these appears to have been lost, for there is none in the M. C. Z. collection and Mortensen states (1907. INGOLF Ech., pt. 2, p. 83) that there is only one in the British Museum.

Cystocrepis.

Mortensen, 1907. INGOLF Ech., pt. 2, p. 84.

Type, *Echinocrepis setigera* A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 78.

Plate 145, figs. *1*, *2*.

Mortensen's reasons for separating from the Crozet Island species, the Panamic echinoid placed in Echinocrepis by Mr. Agassiz, seem adequate. In his description of the pedicellariae, he refers to three kinds, tridentate, rostrate, and ophicephalous. I find the same three kinds but should call them triphyllous, tridentate, and ophicephalous. The triphyllous or small tridentate are very

numerous and have short but distinct necks. The valves (Pl. 145, fig. *2*) are about .15 mm. long, rather wide and flat and finely serrate on the margin. The tridentate or rostrate have the valves (Pl. 145, fig. *1*) less flat, more elongated and more pointed; they are about .35–.40 mm. long but show considerable diversity in size as well as in form. The ophicephalous are well figured by Mortensen. The ALBATROSS took specimens of Cystocrepis at three stations in the Panamic region, at depths of 1573–1879 fms.

Spatagocystis.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.

Type, *Spatagocystis challengeri* A. Agassiz, 1879. *Loc. cit.*

The CHALLENGER collected Spatagocystis in the extreme south of the Indian Ocean in 1600–1950 fms. It has not been met with since.

Ceratophysa.

Pomel, 1883. Class. Meth. Ech., p. 40.

Type, *Pourtalesia ceratopyga* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 205.

This genus contains two species both collected by the CHALLENGER and not since taken. Neither is known from adequate material and it is quite possible that they are not congeneric.

Key to the Species of Ceratophysa.

Anal rostrum rounded . . . . . *ceratopyga.*
Anal rostrum laterally compressed, truncate . . . . . *rosea.*

Ceratophysa ceratopyga.

Pourtalesia ceratopyga A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 205.
Ceratophysa ceratopyga Pomel, 1883. Class. Meth. Ech., p. 40.

This species is one of the largest of the family. Mr. Agassiz estimated from fragments that it attains a length of nearly 200 mm. It was taken by the CHALLENGER in the Antarctic Ocean and off the coast of Chile at depths of 1950–2225 fms.

Ceratophysa rosea.

Pourtalesia rosea A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.
Ceratophysa rosea Pomel, 1883. Class. Meth. Ech., p. 40.

This species, the affinities of which are really quite uncertain, was taken in mid-Pacific, by the CHALLENGER at the notable depth of 2600 fms., a trifle over *three miles*. As only fragments were collected, the size and form are unknown.

Helgocystis.

Mortensen, 1907. INGOLF Ech., pt. 2, p. 82.
Type, *Pourtalesia carinata* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 205.

Here again we have a monotypic genus, with the constituent species known only from fragmentary specimens taken by the CHALLENGER at great depths in the southern Indian (1600 fms.) and Antarctic (1950 fms.) Oceans and off the coast of Chile, (2225 fms.).

Pourtalesia.

A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 272.
Type, *Pourtalesia miranda* A. Agassiz, 1869. *Loc. cit.*

Although monotypic when established, deep-sea exploration has added to this genus nearly a dozen nominal species. Under Mortensen's careful study, and revision, five species have been grouped in other genera, leaving seven to be considered here. Of these, I am convinced that *wandeli* Mortensen is synonymous with *miranda* A. Agassiz. Mortensen himself suggests they are identical. His hesitation in identifying his specimens as *miranda* seems to have been due to expecting too great accuracy of detail in Roetter's drawings of fifty years ago. Mortensen is no doubt correct in estimating that the holotype of *miranda* (which is no longer in existence) was 18–20 mm. long. I have compared a specimen of *wandeli* from West Greenland, identified by Mortensen, with one of *miranda* from Grenada, identified by Mr. Agassiz, and find no difference. The two forms are therefore treated as synonymous. I am tempted to follow the same course with *laguncula* A. Agassiz and *tanneri* A. Agassiz, and perhaps with *alcocki* Koehler, for these three species are very nearly related, and the differences between them (as shown by the key below) are trivial. However as specific lines are very hard to draw in the genus and my material (except of *laguncula*) is scanty, I recognize six species for the present. The form of the test is rather

variable, to judge from *miranda* and *jeffreysi*, the best known species, and the pedicellariae, so well worked out by Mortensen, afford probably the most constant characters.

Key to the Species of Pourtalesia.

Subanal rostrum large and conspicuous.
- Subanal rostrum with sides converging towards the rounded tip which is little or not at all elevated.
  - Width of test about .40 of length; posterior end of dorsal keel not overhanging periproct; valves of rostrate pedicellariae relatively short and wide . . *miranda.*
  - Width of test about .50 of length; posterior end of dorsal keel overhangs periproct more or less conspicuously; valves of rostrate pedicellariae longer and narrower . . . . . *jeffreysi.*
- Subanal rostrum with sides nearly or quite parallel; tip truncate and more or less markedly elevated in adults.
  - Genital plates not completely fused together; size large (40–50 mm.); ophicephalous pedicellariae wanting; rostrate pedicellariae of two kinds . . . *alcocki.*
  - Genital plates completely fused; size not large.
    - Size moderate (20–30 mm.); ophicephalous pedicellariae more or less abundant; rostrate rare or wanting . . . . . *laguncula.*
    - Size small (12–20 mm.); ophicephalous pedicellariae rare or wanting; rostrate more or less abundant . . . . . *tanneri.*

Subanal rostrum small, low, slightly tapering, its length much less than diameter of periproct; tridentate pedicellariae numerous and diversified . . . . . *hispida.*

Pourtalesia miranda.

A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 272.

It is greatly to be regretted that the original specimen on which this interesting species was based is no longer to be found. Its fate is a mystery. As already stated we have material in the M. C. Z. from Grenada collected by the BLAKE, and the INGOLF secured many specimens in the northern Atlantic. It is true that Mortensen questions whether the BLAKE material really is *miranda* but Mr. Agassiz never doubted it and I do not think the differences between the figures of *miranda* given in the Revision of the Echini and these Grenada specimens are really important. They are partly due to inexact details in the figures and are partly a matter of individual diversity.

Pourtalesia jeffreysi.

Wyville Thomson, 1872. Proc. Roy. Soc., **20**, p. 496 (*nomen nudum*).
Wyville Thomson, 1874. Phil. Trans. Roy. Soc., **164**, p. 747.

Thomson gives a brief description of this northern species in his The Depths of the Sea (1873) but it is quite inadequate for the identification of the species

which ought really to date from 1874. As Mortensen has pointed out, *jeffreysi* is characteristic of the cold area of the Norwegian Sea and the northeastern Atlantic, where the INGOLF secured 184 specimens.

Pourtalesia alcocki.

Koehler, 1914. Ech. Indian Mus. Spat., p. 8.

This species was collected by the INVESTIGATOR in the Gulf of Oman at a depth of 1299 fms. It is very near the two following but Koehler compares it more particularly with *jeffreysi* from which it is undoubtedly distinct.

Pourtalesia laguncula.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 205.

This is the only species of the genus represented in the ALBATROSS collections, if we except one small specimen of *tanneri*, and one large fragment from Station 4766 which is probably different but is too incomplete for identification. Nearly all the ALBATROSS material is in poor condition but there are a few whole specimens and some are really good. On these I found many ophicephalous pedicellariae but no rostrate. On the large fragment from St. 4766, there were two rostrate pedicellariae similar to those of *miranda*, but no ophicephalous were found. The fragment includes the anal snout which is dorsally flattened and 10 mm. wide.

Station 3696. Off Manazuru Zaki, Honshu Island, Japan. Bott. temp. 39°. 501–749 fms. Gm. m., vol. a., s.

Station 3697. Off Manazuru Zaki, Honshu Island, Japan. Bott. temp.? 120–265 fms. Gy. m., vol. s.

Station 3737. Off entrance to Port Heda, Honshu Island, Japan. Bott. temp.? 161–167 fms. Gn. m., vol. s.

Station 3738. Off entrance to Port Heda, Honshu Island, Japan. Bott. temp.? 167 fms. Stf. bl. m.

Station 4766. Between Atka Island and Bowers Bank, Bering Sea. Bott. temp.? 1766 fms. Bott? (Probably not *laguncula*).

Station 4906. Southwest of Koshika Islands, Eastern Sea. Bott. temp.? 369–406 fms. Bott.?

Station 4911. Southwest of Koshika Islands, Eastern Sea. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4912. Southwest of Koshika Islands, Eastern Sea. Bott. temp.? 391 fms. Gy. glob. oz.

Station 4913. Southwest of Koshika Islands, Eastern Sea. Bott. temp.? 391 fms. Gy. glob. oz.

Station 4914. Southwest of Koshika Islands, Eastern Sea. Bott. temp. 41.9°. 427 fms. Gy. glob. oz., brk. sh.

Station 4915. Southwest of Koshika Islands, Eastern Sea. Bott. temp.? 427 fms. Gy. glob. oz., brk. sh.

Station 4968. Between Kobe and Yokohama, Japan. Bott. temp. 45.7°. 253 fms. Dk. gy. s., br. m., brk. sh.

Station 5054. Suruga Gulf, Japan. Bott. temp. 45.3°. 282 fms. Gn. m., brk. sh., for.

Station 5055. Suruga Gulf, Japan. Bott. temp. 56.6°. 124 fms. Gn. m., gy. s., brk. sh., p.

Station 5072. Suruga Gulf, Japan. Bott. temp. 44.1°. 148–284 fms. Gy. m.

Bathymetrical range, 120–749 fms. Extremes of temperature, 56.6°–39°. Sixty-eight specimens.

Pourtalesia tanneri.

A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 77.

A single specimen taken by the ALBATROSS in 1888 is of noteworthy interest because it comes from far south of either locality (Gulf of California; Galapagos Islands) whence the species was previously known.

Station 2789. Off the Island of Chiloë, Chile. Bott. temp. 35.9°. 1342 fms. Bu. m.

Pourtalesia hispida.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 204.

Known only from fragments, this is another of the species of which more and better material must be secured before its real relationships are understood. It was taken by the CHALLENGER in the extreme south of the Indian Ocean in 1600–1975 fms.

Echinosigra.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 68, 82.

Although Mortensen considers the structure of the bivium as indicating that these are among "the more primitive Pourtalesiae," I am inclined to consider them (as he has elsewhere expressed it) "an extreme development, the ultimate end of that branch of the great Echinoid genealogical tree." The bivium, it is true, is not so specialized as in some other members of the family but it is scarcely primitive and could even be interpreted as a reversion. The genus contains only two species of which I have seen neither.

Key to the Species of Echinosigra.

Neck short, its least width nearly .20 of test-length . . . . . *phiale.*
Neck long, its least width about .10 of test-length . . . . . *paradoxa.*

Echinosigra phiale.

Pourtalesia phiale (? Wyville Thomson, 1873. Depths of the Sea, p. 90. 1874. Porcupine Ech., p. 749). A. Agassiz, 1881. Challenger Ech., p. 138.
Echinosigra phiale Mortensen, 1907. Ingolf Ech., pt. 2, p. 68, 82.

There can be little doubt that Wyville Thomson and Agassiz had different species in hand when each wrote, but as Thomson's specimens are no longer extant and it is impossible now to determine what his specimens were, I agree with Mortensen that the species described and figured by Agassiz is best considered the true *phiale*. Originally taken by the Challenger in the Antarctic Ocean at a depth of 1975 fms., it has since been taken by the Ingolf south and west of Iceland at lesser depths (845–1300 fms.) and by the Gauss in the Antarctic Ocean again at 1631 fms. Mortensen has compared the Ingolf and Gauss specimens and vouches for their identity.

Echinosigra paradoxa.

Pourtalesia paradoxa Mortensen, 1905. Vid. Med. f. 1905, p. 203.
Echinosigra paradoxa Mortensen, 1907. Ingolf Ech., pt. 2, p. 72, 82.

Judging from Wyville Thomson's figures one might believe that this remarkable form was the one to which he gave the name *phiale* but there is now no way of deciding the question. The Ingolf secured half a dozen specimens of *paradoxa* southwest of Iceland at a depth of 843–912 fms.

PALAEOSTOMATIDAE Gregory.

What to do with the extraordinary sea-urchin described by Gray in 1851 as *Leskia mirabilis* has always been a puzzle, the peristome is so perfectly unique. Lovén considered it the "type" of a "tribe" which he called Palaeostomata, and Mr. Agassiz, in the Revision, placed it in a family by itself, the Leskiadae. Mr. Agassiz recognized that the name Leskia was preoccupied and he accordingly used Palaeostoma instead, but he nevertheless retained the family Leskiadae. And oddly enough, he referred the genus Palaeostoma to Lovén, 1867, p. 432, although Lovén had not suggested a generic name and in all his writings of 1867 and 1868 used the generic name Leskia. Lovén's Palaeostomata was the name of a tribe and while the generic name is a natural derivative therefrom, it is Mr. Agassiz's name and not Lovén's.

Palaeostoma.

A. Agassiz, 1872. Rev. Ech., pt. 1, p. 80, 147.

Type, *Leskia mirabilis* Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 134.

Originally monotypic, this genus remains so today, and no nearly allied Echini have yet been found. The lone species is known only from the East Indian region and as a rule from small specimens. Lovén has critically studied the test and de Meijere and Koehler have each contributed to our knowledge of the spines, pedicellariae, etc. The pedicellariae are of the usual three kinds, globiferous, ophicephalous, and small tridentate; but they are not at all distinctive and beyond the fact that they are of a generalized type, they throw no light on the relationships of Palaeostoma.

AEROPSIDAE, fam. nov.

It is with no little hesitation that I associate together in a single family, the two remarkable genera Aeropsis and Aceste. They agree in the primitive condition of the peristome and in the possession of the peripetalous fasciole alone, but in other respects each is modified in different ways. It seems necessary to unite them in a family by themselves or else to make a family for each and I prefer the former course. My decision is strengthened by Mortensen's

opinion (1907, INGOLF Ech., pt. 2, p. 96) that the two genera are nearly related. He thinks the character of the pedicellariae indicates relationship and to a certain extent this is true but it must be borne in mind that these pedicellariae are of a generalized type and are not at all distinctive. It is, however, worthy of note that ophicephalous pedicellariae are lacking in both genera.

Key to the Genera of Aeropsidae.

Test elongate, more or less cylindrical; mouth flush with ventral surface; ambulacrum III not depressed dorsally . . . . . *Aeropsis.*

Test wide and flattened; mouth vertical; ambulacrum III greatly enlarged and depressed dorsally . . . . . *Aceste.*

Aeropsis.

Mortensen, 1907. INGOLF Ech., pt. 2, p. 90.

Type, *Aerope rostrata* Norman, 1876. Proc. Roy. Soc. London, **25**, p. 212.

Mortensen's alteration of the preoccupied name Aerope to Aeropsis was a happy solution of the difficulty and will no doubt meet with general acceptance. The number of species in the genus is still uncertain owing to lack of material. That there is one species in the North Atlantic seems fairly certain but whether there are two or three species in the Indo-Pacific region or only one is not so clear. There is a possibility as Mortensen suggests that the specimen taken by the CHALLENGER in the Arafura Sea was not the same as the Panamic species. Koehler's *A. sibogae* from the East Indies is based on the specimens which de Meijere identified as *fulva* and I am obliged to consider de Meijere's identification correct. Koehler naturally lays stress on the difference between the rostrate pedicellariae which he found and the one which Mortensen figures for *fulva*, but Mortensen only found a single specimen and it is possible that it was merely a peculiar tridentate. I am inclined to this view because of the fact that in none of the six specimens herein recorded as *fulva* are there any pedicellariae like Mortensen's figure. I am not willing to accept *sibogae* as different from *fulva* on the strength of this one peculiar pedicellaria, and therefore treat Koehler's name as a synonym. There are no other tangible differences between the SIBOGA and the ALBATROSS specimens. By an unfortunate *lapsus calami* on the legend of Koehler's plate II (1914. Ech. Indian Mus. Spat.) the Siboga specimen is called *Aeropsis weberi* and the same error occurs in the explanation of the plate on p. 242.

Key to the Species Aeropsis.

Height of test exceeds one half length; sternum keeled . . . . . *rostrata.*
Height of test less than one half length; sternum not keeled . . . . . *fulva.*

Aeropsis rostrata.

Aerope rostrata Norman, 1876. Proc. Roy. Soc. London, **25**, p. 212.
Aeropsis rostrata Mortensen, 1907. Ingolf Ech., pt. 2, p. 90.

The authority for the name *rostrata* is universally given as Wyville Thomson but Norman's description is ample and antedates Wyville Thomson's by some months. The fact that Norman gracefully calls the name Wyville Thomson's does not affect the case. The specimens before me are 37 mm. long and nearly 20 mm. high. The keel on the sternum is slight but distinct when the specimens are compared with *fulva* of nearly the same size.

Station 2042. Between Cape May, New Jersey, and Nantucket, Western Atlantic. Bott. temp. 38.5°. 1555 fms. Glob. oz.

Station 2043. Between Cape May, New Jersey, and Nantucket, western Atlantic. Bott. temp. 38.5°. 1467 fms. Glob. oz.

Two specimens.

Aeropsis fulva.

Aerope fulva A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 81.
Aeropsis fulva Mortensen, 1907. Ingolf Ech., pt. 2, p. 94.

The specimens before me are from widely separated stations. There can be no doubt that those from 4672 are *fulva*, and I cannot find any satisfactory reason for considering those from 4766 as anything different. The specimens from the latter station have rostrate pedicellariae similar to those described and figured by Koehler for the Siboga specimens, while none of the four specimens from 4672 have any rostrate pedicellariae at all. The largest of the specimens from 4672 is 35 mm. long by 16 mm. high. The specimens from 4766 are fragmentary but the larger was apparently about 40 mm. long.

Station 4672. Eighty-eight miles southwest of Palominos Light House, Peru. Bott. temp. 35.2. 2845 fms. Fne. dk. br. inf. m.

Station 4766. Between Atka Island and Bowers Bank, Bering Sea. Bott. temp.? 1766 fms. Bott.?

Six specimens (several fragmentary).

Aceste.

Wyville Thomson, 1877. Voy. CHALLENGER. The Atlantic, 1, p. 376.

Type, *Aceste bellidifera* Wyville Thomson, 1877. *Loc. cit.*

Mortensen's fear that this generic name might have to be rejected or modified because of the use of Acesta in 1855 for a mollusk does not seem to me well founded. The two names both in sound and appearance are sufficiently different.

Specific differences in Aceste are very slight and that there is really more than a single species seems doubtful. Through the kindness of Mr. Austin H. Clark of the United States National Museum, a fine specimen of *bellidifera* was available for comparison with the ALBATROSS material. I have been over the ground already pretty completely covered by Agassiz, Mortensen, and Koehler, and have little to add to their statements. This review work has satisfied me that the forms called by Mr. Agassiz and myself *ovata* and *purpurea* are really identical but seem to be constantly different from *bellidifera*. I do not see how Koehler's *annandalei* is to be distinguished from *ovata* and must confess that I am inclined to consider the same author's *weberi* (based on a single specimen collected by the SIBOGA and identified by de Meijere as *bellidifera*) as open to grave doubt. The truth is we know almost nothing as to the extent of individual diversity in the genus and it does not seem that Dr. Koehler has made sufficient allowance for it. It may be added here that by the same unfortunate *lapsus calami* referred to above (p. 134), by which *Aeropsis sibogae* is called *A. weberi*, the Aceste properly designated *weberi* is called *A. sibogae*.

Key to the Species of Aceste.

Test sloping forward from apex very distinctly; height near anterior end much less than at posterior.
- Height of test more than half length; sternum and a sort of lower lip formed by the labrum prominent . . . . . *bellidifera.*
- Height of test not more than half length; sternum and labrum not projecting . . . *ovata.*

Test sloping forward from apex very little; height at anterior end nearly equal to that at posterior . . . . . *weberi.*

Aceste bellidifera.

Wyville Thomson, 1877. Voy. CHALLENGER. The Atlantic, 1, p. 376.

Few specimens of this species are known and we therefore lack information about growth-changes and individual diversity. All known specimens

were taken in the middle and southern Atlantic at depths ranging from 620 to 2600 fms.

Aceste ovata.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 258.

In view of Koehler's (1914. Ech. Indian Mus. Spat.) extended descriptions and excellent figures of this species (under the name *annandalei*), it is quite superfluous to redescribe or figure it here. Dr. Koehler had eleven specimens while I have had seventeen so that a fair amount of material has been examined. Koehler's smallest specimen was 19 mm. long while his largest was 35 mm. My largest is of the same size as his but nearly all my specimens are under 20 mm. and my smallest is only 12 mm. long. Koehler is very sure that his specimens should not be referred to *ovata* or *purpurea* but he has made no allowance for the much larger size of his specimens and for individual diversity. The differences which he points out seem trivial and I do not believe they have any taxonomic value. Even the differences which he points out between *annandalei* and *bellidifera*, will largely disappear when sufficient material is examined. The pedicellariae in the specimens from Hawaii and Japan agree very well with Koehler's description and figures but it is obvious that they are not very distinctive.

Station 3836. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands. Bott. temp. 48°. 238–255 fms. Br. gy. m., s.

Station 3839. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands. Bott. temp. 46.3°. 259–266 fms. Lt. br. m., s.

Station 3898. Off Mokuhooniki Islet, Pailolo Channel, Hawaiian Islands. Bott. temp. 44.1°. 258–284 fms. Br. glob. m., fne. s.

Station 4041. Off Kawaihae Light, Island of Hawaii. Bott. temp. 41.6°. 253–382 fms. Gy. m., for.

Station 4666. West of Callao, Peru. Bott. temp. 34.9°. 2600 fms. Fne. gy. rad. oz.

Station 4672. Southwest of Palominos Light House, Peru. Bott. temp. 35.2°. 2845 fms. Fne. dk. br. inf. m.

Station 4911. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4913. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Bathymetrical range 238–2600 fms. Extremes of temperature 48°–34.9°.

Seventeen specimens (some fragmentary).

Aceste weberi.

Koehler, 1914. Ech. Indian Mus. Spat., p. 33.

This species is based on the single specimen of Aceste taken by the SIBOGA. It was secured off Rotti, D. E. I., in 510 fms.

PALAEOPNEUSTIDAE A. Agassiz.

The natural limitations of this family are still unknown. It must be admitted that the general facies of the genera has been an important factor in including them here for in the present state of our knowledge of their development it is impossible to determine their right to be included. On the whole the group as here deliminated seems fairly homogeneous and is certainly not difficult to recognize. Most of the species are rare, deep-water forms, represented in museums by few specimens, and it is safe to say that a large series of specimens of any one species does not exist in any museum. The genera Palaeobrissus A. Agassiz and Meijerea Döderlein would seem to belong in the family also, and they do, but the former is unquestionably based on adult specimens of *Palaeotropus josephinae*, the growth-changes of which are very interesting, while Meijerea seems to be undoubtedly a synonym of Argopatagus. The identity of these last two genera has been overlooked because attention has been directed to the relationship of Meijerea to Phryssocystis, while Argopatagus has been quite ignored. Koehler's genus Paleotrema seems based on a growth-stage of Palaeotropus (*q. v.*).

The twelve genera here recognized as composing this family are distinguished from each other by the presence or absence of marginal, peripetalous, and subanal fascioles, by the shape of the test and the position of the periproct, and by the tuberculation. The form and development of the petals are also of service and the pedicellariae are of some value, but it must be granted that the latter do not often help much in separating the genera. Globiferous pedicellariae are found in only a few genera but tridentate and triphyllous are probably always present. The triphyllous are small and have leaf-shaped valves. The tridentate show very great diversity and in several genera their modified form, called rostrate pedicellariae, are well developed. The ophicephalous are wanting in three genera and in several others have taken on distinctive forms. The most remarkable of these is found in Phryssocystis and Argopatagus, and is quite unlike any other pedicellaria I have seen. The spicules in the tube-feet are often abundant and occur in the form of more or less knobbed rods.

Key to the Genera of Palaeopneustidae.

No subanal fasciole.
- Periproct distinctly on dorsal surface . . . . . *Genicopatagus.*
- Periproct not on dorsal surface.
  - Labium (i. e. a distinct lower or posterior lip) and phyllodes wanting; a complete marginal fasciole present . . . . . *Peripatagus.*
  - Labium and phyllodes well developed.
    - Ambulacra scarcely petaloid; pedicels much reduced.
      - Test more or less depressed with apex not markedly posterior . . *Phryssocystis.*
      - Test high posteriorly where apex and abactinal system are placed. *Delopatagus.*
    - Ambulacra more or less petaloid.
      - Interporiferous areas of petals well developed or at least evident.
        - Actinal ambulacra coarsely tuberculated like the interambulacra; mouth little excentric anteriorly . . . . . *Archaeopneustes.*
        - Actinal ambulacra more or less bare with no large tubercles; mouth markedly anterior.
          - Test high; v. d. much more than half length . . . . *Palaeopneustes.*
          - Test flattened; v. d. much less than half length *Palaeotropus josephinae,* adult.
      - Interporiferous area of petals practically wanting . . . . . *Plesiozonus.*

Subanal fasciole present.
- No large primary tubercles with deeply sunken scrobicules.
  - No peripetalous fasciole.
    - Subanal fasciole more than twice as wide as long . . . . . *Argopatagus.*
    - Subanal fasciole not twice as wide as long.
      - Posterior ambulacra dorsally subpetaloid, much wider than anterior pair . . . . . *Nacospatangus.*
      - No ambulacra at all petaloid . . . . . *Palaeotropus.*
  - Peripetalous fasciole present . . . . . *Pycnolampas.*
- Some large primary tubercles with deeply sunken scrobicules in dorsal interambulacra . . . . . *Homolampas.*

Genicopatagus.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 210.

Type, *Genicopatagus affinis* A. Agassiz, 1879. *Loc. cit.*

This is a monotypic genus which has not been met with since the CHALLENGER collected specimens at a depth of 1950 fms. in the Antarctic Ocean. I have never seen one so can add nothing to our knowledge of the genus.

Peripatagus.

Koehler, 1896. Bull. Soc. Zool. France, **20**, p. 231.

Type, *Peripatagus cinctus* Koehler, 1896. *Loc. cit.*

This is another monotypic genus of which I have seen no specimens. It was taken by the PRINCESS-ALICE in 489–830 fms. in the eastern Atlantic.

Phryssocystis.

A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 80.

Type, *Phryssocystis aculeata* A. Agassiz, 1898. *Loc. cit.*

This genus is known only from fragments taken by the Albatross, once near Cocos Island and once at an unknown station supposedly in the Hawaiian Islands. No whole specimens were secured, the test being exceptionally thin and fragile, but from a study of the fragments Mr. Agassiz worked out the form and structure of the test and I found a number of pedicellariae. The ophicephalous pedicellariae are particularly remarkable and show the close relationship of this genus to Argopatagus, the only other genus of Echini known to have such curious pedicellariae. In view of what I have learned in regard to growth-changes in Palaeotropus, it is quite possible that Phryssocystis will ultimately prove to be the adult of Argopatagus.

Key to the Species of Phryssocystis.

Primary tubercles on each abactinal plate in mid-zone, 2–8; color yellowish brown . . *aculeata.*
Primary tubercles on each abactinal plate in mid-zone, 8–12; color deep red-brown . . *multispina.*

Phryssocystis aculeata.

A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 80.

Mr. Agassiz has so fully described and beautifully figured this species, I need only speak of the pedicellariae. I have failed to find the characteristic pedicellariae but have no doubt this is due to the scanty available material. The tridentate and triphyllous were both found but are not abundant on the fragments at hand. These pedicellariae are very similar to those of the following species and no constant differences were noted. The only known specimens of *aculeata* were taken east of Cocos Island, Eastern Pacific Ocean, in 1067 fms. but reached the surface in fragments.

Phryssocystis multispina.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 252.

Plates 145, figs. *7–12*; 151, figs. *1–4*.

It is greatly to be regretted that neither the place nor the depth at which this interesting species was taken are known. The jar containing the frag-

ments had no label whatever but it was with the ALBATROSS Hawaiian collection and there is no reason to doubt that the material is from somewhere in the vicinity of the Hawaiian group. The fragments are mostly small but a few are 40–50 mm. across. Not less than two individuals and possibly three, were the source of these pieces. All are of a deep red-brown color quite different from that of *aculeata*, and the long spines have a distinctly reddish tinge. Fragments from the ventral surface (Pl. 151, fig. *1*) bear numerous primary tubercles and spines, the latter more or less spatulate at tip and distinctly prickly. A large abactinal fragment (Pl. 151, fig. *2*) shows the madreporite and the four genital pores. The primary spines of the dorsal side are acute and very prickly. They are quite numerous, the plates of the mid-zone usually having as many as 10–12 primary tubercles, seldom as few as 8.

The periproct (Pl. 151, fig. *4*) is nearly circular, about 16 mm. across, while the peristome (Pl. 151, fig. *3*) is relatively very large, 32–35 mm. wide and 12–16 mm. long. The labium is large and conspicuous. Pedicellariae are numerous and diversified. The triphyllous have long necks, as is usual, but the valves (Pl. 145, fig. *9*) are quite like very small tridentate; they are relatively large measuring .20–.25 mm. in length. The tridentate are very diversified, the two extremes being very different but apparently intergrading, though intermediate forms are rare. The broad tridentate (rostrate?) have the valves (Pl. 145, fig. *11*) .25–1 mm. long with a rather flattened leaf-like blade, more or less involute at the end of the apophysis. In the narrow tridentate, the valve is slender (Pl. 145, fig. *12*), 70–1.10 mm. in length, with the blade more or less strongly compressed. There is considerable mesh-work at the back of the blades in the largest ones. The ophicephalous pedicellariae (Pl. 145, fig. *7*) have the heads nearly spherical and the upper end of the stalk (Pl. 145, fig. *10*) enormously enlarged and very deeply concave. The valves (Pl. 145, fig. *8*) measure about half a millimeter in length and width and have no distinction between blade and base, though the apophysis is well developed.

Delopatagus.

Koehler, 1907. Zool. Anz., **32**, p. 147.

Type, *Delopatagus brucei* Koehler, 1907. *Loc. cit.*

This is a remarkable monotypic genus known only from 2425 fms. in the Antarctic Ocean, south of South Georgia Island, where one specimen was secured by the SCOTIA.

Archaeopneustes.

Gregory, 1892. Quart. Journ. Geol. Soc. London, **48**, p. 163.
Type, *Palaeopneustes hystrix* A. Agassiz, 1880. Bull. M. C. Z., **8**, p. 82.

This genus was proposed by Gregory for *Palaeopneustes hystrix* and certain West Indian fossil species. The characters he selected, however, (petal length and form, and position of the mouth) are most unfortunate and he quite overlooked the really important character (tuberculation of actinal ambulacra) pointed out by Koehler in 1914. Gregory quite reversed the facts as to the position of the mouth because he relied on A. Agassiz's figure (1883. Blake Ech., pl. xxi, fig. 11) of a *very young cristatus*, whereas the figure of the adult given by Mr. Agassiz (1874. Hassler Ech., pl. iv, fig. 3) with his original full description shows clearly the very anterior position of the mouth. Petal length and form vary somewhat with age and I fail to find even specific differences therein. Besides the West Indian type species two Oriental forms seem to belong here. I find no ophicephalous pedicellariae present in the West Indian species but they occur in both the others. Tridentate pedicellariae, rostrate and triphyllous all occur in great numbers but the rostrate are not always clearly separable from the broad tridentate. Calcareous particles in the pedicels are scattered knobbed rods (Pl. 145, fig. *20*) which in the penicillate pedicels about the mouth become more or less slender perforated plates.

Key to the Species of Archaeopneustes.

Test of moderate height, v. d. not exceeding .60 length.
- Mouth distinctly anterior; anterior margin of labium only about .30–.35 test-length from anterior margin of test; test low, v. d. not exceeding half test-length . . . *hystrix*.
- Mouth less anterior; anterior margin of labium about .40 test-length from anterior margin of test; v. d., .50–.58 test-length . . . . . *niasicus*.

Test high; v. d. .61–.73 test-length; anterior margin of labium about .40 test-length from anterior margin of test . . . . . *hemingi*.

Archaeopneustes hystrix.

Palaeopneustes hystrix A. Agassiz, 1880. Bull. M. C. Z., **8**, p. 82.
Archaeopneustes hystrix Gregory, 1892. Quart. Journ. Geol. Soc. London, **48**, p. 163.

Plate 145, figs. *20–26*.

The pedicellariae alone remain to be described of this West Indian species. It is rather remarkable that I found no ophicephalous and no globiferous pedicellariae, though the latter are not known in the genus. The triphyllous (Pl.

145, fig. *23*) have rounded leaf-shaped valves (Pl. 145, fig. *21*) about .12–.15 mm. long. The tridentate are abundant, of two quite different types which tend to intergrade, though true intermediates are rare. The stout tridentate (or rostrate?) (Pl. 145, fig. *22*) have the valves .40–1.50 mm. long, but little curved and rather abruptly expanded at the tip (Pl. 145, fig. *26*) below which the margins tend to be involute and carry a few large teeth. The slender tridentate (Pl. 145, fig. *24*) have the valves .50–2.10 mm. long, with the tips (Pl. 145, fig. *25*) pointed and involute. The calcareous particles in the tube-feet (Pl. 145, fig. *20*) are widely scattered and not at all distinctive.

Archaeopneustes niasicus.

Palaeopneustes niasicus Döderlein, 1900. Chun's Auf Tief. Welt., figs., p. 360.
Archaeopneustes niasicus Koehler, 1914. Ech. Indian Mus. Spat., p. 54.

This species was taken by the VALDIVIA off the west coast of Sumatra in 261 fms. It is rather remarkable that it should resemble *hystrix* so closely, but the pedicellariae are noticeably different, as ophicephalous occur and the broad tridentate are very clearly rostrate in form.

Archaeopneustes hemingi.

Palaeopneustes hemingi Alcock, 1902. A Naturalist in Indian Seas, fig. 22, opp. p. 168.
Archaeopneustes hemingi Koehler, 1914. Ech. Indian Mus. Spat., p. 52.

This is the Indian Ocean species taken by the INVESTIGATOR in 224–284 fms. Many specimens were taken but only at a single station. The rostrate pedicellariae as figured by Koehler are very characteristic.

Palaeopneustes.

A. Agassiz, 1873. Bull. M. C. Z., **3**, p. 188.

Type, *Palaeopneustes cristatus* A. Agassiz, 1873. *Loc. cit.*

Like the preceding this genus consists of one West Indian and two Oriental species, but the specific differences are very much better marked. Koehler indeed places (1914. Ech. Indian Mus. Spat. p. 62) *spectabilis* in Linopneustes but while there is room for difference of opinion, in my judgment its nearest relative is *Palaeopneustes cristatus*. The latter shows in some specimens more

or less of a marginal fasciole,[1] and the absence of a subanal fasciole in *spectabilis* seems to me a more serious matter than it does to Dr. Koehler. Unfortunately the pedicellariae give little assistance since the two genera show no notable differences. Pedicellariae in Palaeopneustes are abundant and varied. No globiferous have been found but all of the other varieties occur. They resemble in their main features those of Archaeopneustes.

Key to the Species of Palaeopneustes.

Primary spines numerous, not conspicuously longer and larger than the secondaries.
Ambulacrum III not at all sunken; petaloid area of ambulacrum II only 6–10 mm. wide at distal end; labrum scarcely twice as long as wide; color dark violet . . *cristatus.*
Ambulacrum III depressed as a shallow furrow; petaloid area of II, 12–18 mm. wide; labrum thrice as long as wide; color red-brown with violet tinge . . . *fragilis.*
Primary spines relatively few, long and conspicuous; labrum more than thrice as long as wide . . . . . *spectabilis.*

Palaeopneustes cristatus.

A. Agassiz, 1873. Bull. M. C. Z., **3**, p. 188.

Plate 145, figs. *13–19.*

Of this fine West Indian spatangoid, only the pedicellariae need description. They are exceedingly abundant and show great diversity of form. The ophicephalous, with valves (Pl. 145, fig. *19*) about .35 mm. long (including the loop), have the blade triangular and wider than long. The triphyllous are not very abundant; they have long necks and very small heads, the valves (Pl. 145, fig. *16*) only .10 mm. long. The rostrate, with valves (Pl. 145, figs. *13*, *14*) about .30–.50 mm. long, are fairly numerous; they are apparently only broad tridentates modified to an extreme. There seem to be also at least four forms of tridentate. The largest have valves (Pl. 145, fig. *15*) about a millimeter long, the blade narrow and somewhat involute but rapidly expanding at tip. A second sort are similar but have shorter valves with wider blades. In a third form, the valves (Pl. 145, fig. *17*) are about .30–.50 mm. long with rather broad blades not at all abruptly enlarged at tip. Finally in the fourth form, the valves (Pl. 145, fig. *18*) are very narrow, pointed, decidedly curved

[1] Mr. Agassiz in the Blake Echini, p. 58, discusses the fasciole present in a specimen 45 mm. long, and seems uncertain whether it is a marginal fasciole or not. In my opinion, it is certainly a true marginal fasciole, which though very tenuous is quite complete. Moreover in this same specimen there are distinct fragments of a peripetalous fasciole. But neither in this, nor in any other specimen is there the least indication of a subanal fasciole.

and meeting only at tip; they are .25–.50 mm. long. Of course more or less intermediate forms occur connecting these varieties with each other and even with the rostrate. Calcareous rods in the pedicels are few and scattered. The sphaeridia are elongated and not at all spherical.

Palaeopneustes fragilis.

De Meijere, 1902. Tijd. Ned. Dierk. Vereen, (2), **8**, p. 12.

This species was taken by the SIBOGA in the Dutch East Indies in 402–566 fms. It was subsequently taken by the ALBATROSS off the eastern coast of Japan. All of the specimens were large and badly broken. The one most nearly whole is about 125 mm. long. These specimens answer well to de Meijere's full description and figures in his SIBOGA Echini and there can be little doubt of the identification.

Station 4969. Between Kobe and Yohohama, Japan. Bott. temp. 38.9°. 587 fms. Br. m., s., st.

Station 4970. Between Kobe and Yokohama, Japan. Bott. temp. 39.1°. 500–649 fms. Br. m., bk. s., sh.

Station 5053. Suruga Gulf, Japan. Bott. temp. 34.9°. 503 fms. Gn. m.

Station 5080. Off Omai Saki Light, Japan. Bott. temp. 38.7°. 505 fms. Fne. gy. s., glob.

Bathymetrical range, 500–649 fms. Extremes of temperature, 39.1°–34.9°.

Four specimens.

Palaeopneustes spectabilis.

De Meijere, 1902. Tijd. Ned. Dierk. Vereen, (2), **8**, p. 11.

This species is also one of the SIBOGA'S prizes. It was taken at three stations in the Dutch East Indies in 250–289 fms.

Plesiozonus.

De Meijere, 1902. Tijd. Ned. Dierk. Vereen, (2), **8**, p. 12.
Type, *Plesiozonus hirsutus* de Meijere, 1902. *Loc. cit.*

This is another monotypic genus based on a single specimen taken in 289 fms. near the Paternoster Islands, D. E. I., by the SIBOGA. The genus is remarkably well characterized by the unusual ambulacra.

Argopatagus.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 209.

Type, *Argopatagus vitreus* A. Agassiz, 1879. *Loc. cit.*

It was with great surprise that I made the discovery that Döderlein's genus Meijerea is identical with Argopatagus, and that the type species, *M. humilis* (= *Phryssocystis humilis* de Meijere), and the Hawaiian form to which Mr. Agassiz and I gave the name *M. excentrica* are both identical with the CHALLENGER species, *Argopatagus vitreus*. I have never seen any of the CHALLENGER specimens and know nothing of their pedicellariae. The few specimens of the genus at hand have pedicellariae like those figured by Döderlein (1906. VALDIVIA Ech., pl. xlix, fig. 7). The remarkable ophicephalous pedicellariae are highly characteristic and indicate a close relationship with Phryssocystis, the only other genus of Echini with such curious pedicellariae. It is possible that there is only one species of Argopatagus but I cannot believe that the specimen from station 4919 is the same as the others. Accordingly two species, distinguished primarily by the difference in the form of the test are recognized.

Key to the Species of Argopatagus.

Test highest at or just back of the middle . . . . . *vitreus.*
Test highest at posterior end where it is abruptly truncate . . . . . *planus.*

Argopatagus vitreus.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 209.

This species was first collected by the CHALLENGER, which took several specimens in the Arafura Sea at 800 fms. The SIBOGA took a single specimen in 257 fms. just south of Celebes, but de Meijere, struck by the resemblance to *Phryssocystis aculeata*, failed to compare it with Argopatagus and described it as *Phryssocystic humilis*, a new species characterized by having a subanal fasciole. The VALDIVIA took a similar specimen, just south of the Maldives in 1252 fms. which Döderlein recognized as de Meijere's species, but because of the subanal fasciole he made it the type of a new genus Meijerea. Like de Meijere he failed to note the identity with Argopatagus. The ALBATROSS took, at a depth of 670–697 fms. among the Hawaiian Islands, a similar speci-

men, and Mr. Agassiz and I, noting the close resemblance to the SIBOGA and VALDIVIA specimens, and without thinking of Argopatagus, accepted the genus Meijerea and described our specimen as *M. excentrica*. A few months later we found additional material in the ALBATROSS Japanese collections but we still failed to think of Argopatagus. When, however, I came to revise all the genera of spatangoids, the resemblance of Meijerea to Argopatagus struck me and I soon reached the conclusion that the two names refer to the same animal. Critical comparison of the Hawaiian specimen of *excentrica* with the description and figures of Argopatagus in the CHALLENGER Report prove that they are identical. The larger specimens from Japan are evidently *humilis*, yet there is no doubt they are the same as *excentrica*. I am satisfied therefore that both *Phryssocystis humilis* de Meijere and *Meijerea excentrica* A. Agassiz and Clark are synonyms of *Argopatagus vitreus*. The best of our Japanese specimens is almost exactly like de Meijere's photographs in the Siboga Report. The pedicellariae of this species have been very fully and satisfactorily figured by Döderlein, and de Meijere also gives some sketches. Further details are therefore not needed here.

Station 4039. Off Kawaihae Light, Hawaii, H. I. Bott. temp. 38.7°. 670–697 fms. Gy. m., for.

Station 4908. Southwest of Koshika Islands, Japan. Bott. temp. 42.9° 434 fms. Gy. glob. oz.

Station 4911. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4912. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4914. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 427 fms. Gy. glob. oz., brk. sh.

Station 4956. Between Kagoshima and Kobe, Japan. Bott. temp. 37.5°. 720 fms. Gn. br. m., fne. gy. s., for.

Station 4980. South from Hamamatsu, Japan. Bott. temp. 39°. 507 fms. Br. m., fne. s., for.

Bathymetrical range, 391–720 fms. Extremes of temperature, 42.9°–37.5°.

Three specimens and many fragments.

Argopatagus planus.

Meijerea plana A. Agassiz and Clark, 1907. Bull. M. C. Z., **51**, p. 132.

Plate 151, figs. *6–8*.

Length 28 mm.; breadth in front of abactinal system, 22 mm.; height at posterior end, 9 mm. and at anterior end 4 mm. The shape of the thin, fragile test will be best understood from the figures *6*, *7* and *8* (Pl. 151), which also show clearly the tuberculation. The abactinal system is a little back of the middle of the test; it is small and compact and there are no genital pores visible; even the ocular pores are hard to detect. The labrum is narrower than in *vitreus* and has a nearly straight anterior margin; it carries a very few small tubercles near the mouth. There is considerable tuberculation about the ambitus but there is nothing like a true marginal fasciole. The subanal fasciole is very well developed, not at all angular and encloses a space 6 mm. wide by 2 mm. high. The periproct is on the vertical posterior surface. The primary spines are all broken but were evidently about 6–8 mm. long, whitish, glassy, and sparsely prickly. Of pedicellariae, I have found only a single tridentate, the valves of which are narrow, about half a millimeter long and .06 or .07 mm. across the blade, .10–.12 mm. across the base. The color of the test is light brown.

After comparison with the specimens of *vitreus*, which are decidedly larger and with the various figures of that species which have been published, it is evident that this unique individual represents a different species. Besides the marked difference in the form of the test, an excellent specific character for *planus*, to separate it from *vitreus*, is found in the arrangement of the plates around the peristome, where interambulacra 1 and 4 are completely shut out by the contact of I*b*1 and II*a*1 and of IV*b*1 and V*a*1 (Pl. 151, fig. 7). This may of course prove to be an individual peculiarity but for the present it may well be considered a good specific character.

Station 4919. Off Kagoshima Gulf, Japan. Bott. temp. 41.8°. 440 fms. Glob. oz.

One specimen.

Nacospatangus.[1]

A. Agassiz, 1873. Bull. M. C. Z., **3**, p. 189.

Type, *Nacospatangus gracilis* A. Agassiz, 1873. *Loc. cit.*

Originally based on material taken by the HASSLER, this genus has remained little known. Mr. Agassiz (1904. Mem. M. C. Z., **31**) has published notes and figures supplementary to those in the HASSLER report, but based on the same material. I am now able to give an account of the pedicellariae and in addition, to describe a second species. The study of all the available material has not shown what the true relationships of the genus are. The character of the ambulacra dorsally has led me to put it in the Palaeopneustidae but this character is misleading and I am inclined to believe the nearest relatives of Nacospatangus are in the Spatangidae, perhaps in the vicinity of Metalia and Rhynobrissus.

Key to the Species of Nacospatangus.

Height of test .60 length; width over .80 length; test widest well back of apical system; globiferous pedicellariae with short teeth around mouth of valves . . . . . *gracilis.*

Height of test about .50 length; width under .80 length; test widest at apical system; globiferous pedicellariae with long teeth around mouth of valves . . . . . *depressus.*

Nacospatangus gracilis.

A. Agassiz, 1873. Bull. M. C. Z., **3**, p. 189.

Plate 145, figs. *35–39.*

There are neither ophicephalous nor rostrate pedicellariae, but tridentate are fairly common, and both triphyllous and globiferous occur, and the latter, though small are very characteristic. The valves (Pl. 145, figs. *35*, *36*) have a broad base and a short, cylindrical curved blade, with the terminal opening surrounded by half a dozen short teeth (Pl. 145, fig. *37*), and measure .20–.25 mm. in length. The tridentate are not very variable; the valves, (Pl. 145, fig. *39*) are about .17–.25 mm. long with the blade about one fourth as wide. The triphyllous have very broad valves (Pl. 145, fig. *38*) only about .05 or .06 mm. long.

[1] The name is spelled Nacospatagus in both the CHALLENGER and Panamic reports and the error has been often copied.

These pedicellariae were all found on Mr. Agassiz's original material from near Juan Fernandez in 65 fms.

Nacospatangus depressus, sp. nov.

Plate 145, figs. *40–43*.

Length of test, 11.5 mm.; breadth at apical system, where it is widest, 8.75 mm.; height 5.25 mm., the greatest height being well back of the abactinal system near the posterior end of the test. From the apical system the test slopes forward at first gradually and then rather abruptly. The posterior end of the test above the subanal plastron is vertical and is largely occupied by the periproct, the plates of which carry a few minute pedicellariae but are otherwise bare. The abactinal system is so compact I am unable to make out the separate plates. The only genital pore is that in genital 3. The petals are essentially as in *N. gracilis* so that Mr. Agassiz's figure (1904. Mem. M. C. Z., **31**, pl. 98, fig. *3*) answers well for *depressus* in that particular, and in the tuberculation also. Mr. Agassiz's figure *2* would answer for *depressus* so far as arrangement of plates and tuberculation go, but in *depressus* the peristome is shorter, wider, and less pentagonal, the labrum is longer (being broadly in contact with the second ambulacral plate on each side) and the subanal fasciole is wider and encloses an area which is almost circular (a bit pointed on the side towards the mouth) and nearly or quite as long as wide. It should be added, however, that this apparently great difference in the fasciole is not real, but is due to foreshortening in Mr. Agassiz's figure. When specimens are compared, the two species agree in the form of the fasciole. The sternum is somewhat flatter in *depressus* than in *gracilis* but the difference is not conspicuous. The color (dry) is light wood-brown.

The pedicellariae of *depressus* are characteristic. The tridentate are very scarce and small, with straight narrow valves (Pl. 145, fig. *40*) only .15–.20 mm. long. The globiferous are common and have very large glands on the small valves (Pl. 145, figs. *41*, *42*), which are .15–.20 mm. long. The teeth around the terminal opening of the blade (Pl. 145, fig. *43*) are long and slender. No triphyllous, rostrate, or ophicephalous pedicellariae were found, nor calcareous particles in the tube-feet.

While there is no doubt that this species is nearly related to *gracilis*, the differences in the shape of the test and in the globiferous and tridentate pedicel-

lariae, seem to warrant its recognition. The smaller of the two specimens is 10 mm. long by 8 mm. wide and a trifle more than 5 mm. high but the form of the test is like that of the holotype.

Station 2922. Off southern California. Bott. temp. 57.1°. 47 fms. Fne. gy. s.

Two specimens.

Palaeotropus.

Lovén, 1872. Öfv. Vet. Akad. Förh. f. 1871, no. 8, p. 21.

Type, *Palaeotropus josephinae* Lovén, 1872. *Loc. cit.*

As already stated (p. 138) the genera Palaeobrissus and Paleotrema are based on growth-stages of Palaeotropus, as I have determined from the study of the material in the M. C. Z. Palaeotropus is a small genus of four, or possibly only three, species, easily recognized by the totally apetaloid nature of the abactinal ambulacra, associated with a well-marked nearly circular subanal fasciole and no other. Pedicellariae are numerous and varied, all five forms having been found within the genus, but they are of little taxonomic value, though now and then they furnish good characters. The species are distinguished by the form of the test, the position of the periproct, the shape of the peristome, and the number of genital pores. This last character is of very doubtful value for as will be seen under *P. josephinae* (p. 152), sexual maturity is attained slowly in Palaeotropus and apparently grown specimens may not have the normal number of genital pores.

Key to the Species of Palaeotropus.

Test highest posteriorly; subanal fasciole, when present, not longer than wide; periproct at or above posterior margin of test.
- Test not narrower in front than behind.
  - Peristome 1.5–3 times as wide as long; test wider in front than behind, becoming much flattened in adults; genital pores 2, 3 or 4 according to age . . . . . *josephinae.*
  - Peristome about as long as wide; test not wider in front than behind; genital pores 3 (?) . . . . . *ovatus.*
- Test distinctly narrower in front than behind; genital pores 3 . . . . . *loveni.*

Test highest near middle; height more than half length; subanal fasciole longer than wide; periproct below posterior margin of test; genital pores 4 . . . . . *thomsoni.*

Palaeotropus josephinae.

Lovén, 1872. Öfv. Vet. Akad. Förh. f. 1871, no. 8, p. 21.

Plate 145, figs. *27–34*.

Although the amount of material in the M. C. Z. is not very great it is sufficient to show that Mr. Agassiz's *Palaeobrissus hilgardi* is the adult of this species, which was described from immature specimens, only 11–12 mm. long. Unfortunately I have not seen Lovén's type but I do not think Mr. Agassiz made a mistake in considering the small specimens of Palaeotropus taken by the Blake, identical with Lovén's species. One of these now before me is less than 17 mm. long, is 10 mm. high and shows 2 distinct genital pores and a very distinct subanal fasciole. The height is a little more than .60 of the length. In Lovén's much smaller specimen the height was .61 of the length. A specimen 23 mm. long is no higher than the smaller one (10 mm.) and hence the height is only .44 of the length, but the subanal fasciole is very distinct and there are only two genital pores. A third specimen, 28 mm. long is 12 mm. high (height = .43 of length) has the subanal fasciole evident but not complete and a third genital pore is present, though very small; it lies in genital 3. A fourth specimen, one of the types of *Palaeobrissus hilgardi*, is 42 mm. long and 16 mm. high (height = .38 of length); there is no indication of a subanal fasciole but there are only two genital pores of normal size, the one in genital 3 being small and functionless. Finally the specimen figured in the Blake Report (Pl. 24, fig. 15) is 47 mm. long, 15 mm. high (height = .32 length), shows no trace of a subanal fasciole and has 4 genital pores, though the two anterior are decidedly smaller. I think no one can examine this series of five specimens without being satisfied that they represent a single species, and that it is exceedingly difficult, if not impossible, to doubt that they are all *josephinae*. It is evident that the number of genital pores is a matter of age, as is also the condition of the fasciole and the flatness of the test. I believe too that the arrangement of the dorsal plates in the ambulacra (I and V especially) depends largely on age but is also subject to individual diversity; it seems therefore conclusive that not only is *Palaeobrissus hilgardi* a synonym of *Palaeotropus josephinae* but the same is true of Koehler's *Palaeotropus hirondellei*. Koehler apparently overlooked the facts that the Azores are the type locality for *josephinae*, and that the figures in the Blake Report are from much larger specimens. Comparison of the figures here given of the pedicellariae of West Indian specimens (*"hilgardi"*) with

Koehler's figures (1909. Princesse-Alice Ech., pl. xxx, figs. 18–22) show some striking differences, but in view of Koehler's later figures (1914. Ech. Indian Mus. Spat., pl. XVII, figs. 30, 31) and his own comments on his earlier figures, these need not cause any surprise. Globiferous pedicellariae are common; the valves (Pl. 145, figs. *29*, *30*) are .17–.27 mm. long and terminate in two long teeth; the stalks are rounded at the top and have a slight but distinct swelling well above the middle. Tridentate pedicellariae are less common; the valves (Pl. 145, fig. *34*), are .35–.50 mm. long, coarsely, and irregularly serrate on the nearly parallel margins; the stalks are rounded and slightly enlarged at the top. The rostrate pedicellariae are found only on or close to the periproct; the valves (Pl. 145, figs. *32*, *33*) are from .25–.35 mm. long and distinctly curved. The ophicephalous are abundant; the valves (Pl. 145, fig. *27*) are .10–.17 mm. long with the loop .05–.08 mm. more; the stalk is as usual, enlarged and hollowed out at the top. The triphyllous are very minute and apparently scarce; the valves (Pl. 145, fig. *28*) are little more than .05 mm. long. The calcareous particles in the tube-feet (Pl. 145, fig. *31*) are not peculiar, simply curved slightly knobbed rods.

Palaeotropus ovatus.

Koehler, 1914. Ech. Indian Mus. Spat., p. 39.

The differences between this species and *josephinae* seem of very doubtful value. The single known specimen, only 12.4 mm. long and hence very young was taken by the Investigator in 60–75 fms. in the Bay of Bengal.

Palaeotropus loveni.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 204.

Examination of some cotypes revealed only tridentate pedicellariae, with valves .15–.25 mm. in length. In form they resemble those described and figured for *ovatus* by Koehler (1914. Ech. Indian Mus. Spat., p. 42; pl. xvii, fig. 35). The spicules in the tube-feet are distinctly more slender than those of *josephinae*. The Philippine Islands, north of Mindanao, in 375 fms., is the type locality for *loveni*, and one specimen was taken by the Siboga south of Timor in 120 fms.

Palaeotropus thomsoni.

A. Agassiz, 1880. Bull. M. C. Z., **8**, p. 80.

Plates 145, figs. *44–46*; 158, figs. *6*, *7*.

This highly interesting spatangoid was taken by the BLAKE east of Charleston, S. C., in 233 fms. Mr. Agassiz published no figures and gives only a very brief description although he recognized the unusual nature of the specimen. The two figures of the test, one (Pl. 158, fig. *6*) as seen from above, the other (fig. *7*) as seen from the side, bring out well its peculiar features. The oral surface is so badly damaged no information can be given about the labrum and its adjoining plates. The posterior ambulacra as well as the anterior continue to the oculars in double series, though they become very narrow and the plates alternate more or less. There are distinct pieces of a very narrow peripetalous fasciole but it is strikingly incomplete. There are four nearly equal genital pores, though the posterior are a little the larger.

Of pedicellariae, there appear to be four kinds but no globiferous were found. Of the ophicephalous, only one was found and that was very small with valves only .12 mm. long plus the loop of .06 mm. Triphyllous pedicellariae are also rare and very small; the valves are .07 mm. long and broader than in *josephinae*. The tridentate are common but small; the valves (Pl. 145, fig. *46*) are straight and more or less compressed, but only .15–.25 mm. long. The rostrate pedicellariae are quite distinctive; the valves are quite deep, .25–.50 mm. long, and have the margin of the terminal opening (Pl. 145, fig. *44*) with numerous teeth; the stalks (Pl. 145, fig. *45*) are very remarkable because of the pronounced "limb" which is near the base, instead of below the tip.

Pycnolampas.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 252.

Type, *Pycnolampas oviformis* A. Agassiz and Clark, 1907. *Op. cit.*, p. 253.

This genus was established for some small spatangoids from the Hawaiian Islands allied to Homolampas. The specimens are obviously immature, as even the largest has no genital pores, but the difference from Homolampas of somewhat larger size is so evident that it is highly improbable that these individuals are the young of any species of that genus. The two most important differences are the evidently petaloid nature of the posterior ambulacra, which

is more distinct in the larger than in the smaller specimens, and in ambulacrum III being perfectly flush with the surface of the test instead of being sunken. There are a few big primary tubercles in the interambulacra within the peripetalous fasciole, as in Homolampas, but the scrobicules are not sunken as in that genus. This difference, however, is very likely a matter of age and I believe that in the adult Pycnolampas the scrobicules will be found to be sunken. Until adult specimens are found, however, the original diagnosis of the genus stands.

Pycnolampas oviformis.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 253.

Plate 147, figs. *4–6*.

Length 22 mm.; breadth where widest, just back of abactinal system, 17 mm.; height where highest, just back of abactinal system 9.5 mm. The area enclosed by the peripetalous fasciole is about 14 mm. long by 12 mm. wide. The fasciole itself is very narrow, well marked on the sides but not so distinct anteriorly and posteriorly. Ambulacrum III is indistinct, not at all depressed and with few minute pores. Poriferous areas of the other ambulacra evident (Pl. 147, fig. *5*), those of the posterior pair especially tending to become petaloid within the fasciole. Periproct about as wide as high, occupying most of the vertical posterior end of test. Subanal fasciole well marked, its enclosed area about 5 mm. wide and 4 mm. long. Peristome almost perfectly flush with oral surface of test, with no distinct labium and with mouth near its center; the peristome is 3.5 mm. wide, 3 mm. long and its anterior margin is only 5 mm. from the anterior margin of the test. The labrum (Pl. 147, fig. *6*) is very long and narrow, in contact with three ambulacral plates on each side. The posterior pair of ambulacra, orally (Pl. 147, fig. *6*) are broad and perfectly bare; five ambulacral plates enter the subanal fasciole on each side but only three carry large penicillate feet (Pl. 147, fig. *4*). The color of the preserved material is very pale yellowish or grayish, with the fascioles darker.

The primary spines are 6–8 mm. long and appear under a lens to be perfectly smooth. Secondary spines similar but much smaller, about 2 mm. long, are common especially near the ambitus, and miliary spines, a millimeter or less in length sparsely cover the test, except orally in the ambulacra. Pedicellariae of three kinds occur but they are not at all distinctive. The tridentate are rather rare; they have very narrow nearly straight valves, about half a milli-

meter long, with margins coarsely serrate near middle but becoming finely serrate distally. Ophicephalous pedicellariae are common but very small with the valves only .07–.15 mm. long, plus .05–.10 mm. more for the loop; the blade is noticeably long and narrow with numerous teeth or prickles on the thickened margin. Triphyllous pedicellariae with very long necks are common; the small leaf-shaped valves are scarcely .07 mm. long. Calcareous particles in the pedicels, in the form of knobbed or rough rods are fairly common.

The specimens from 3890 and 4044 are much smaller than those from 3838, the length being about 15 mm. The test is relatively less flattened, the peripetalous fasciole is less distinct (it can hardly be made out in the smallest specimen) and the ventral ambulacra are not so bare. These differences are of interest only as throwing light on the growth-changes.

Station 3838. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands. Bott. temp. 67°. 92–212 fms. Fne. gy. br. s.

Station 3890. Off Mokapu Islet, Molokai, H. I. Bott. temp. 71.2°. 71–283 fms. Bk. s.

Station 4044. Off Kawaihae Light, west coast of Hawaii, H. I. Bott. temp. 47°. 198–233 fms. Fne. gy. s.

Bathymetrical range, 71–283 fms. Extremes of temperature, 71.2°–47°.

Five specimens.

Homolampas.

A. Agassiz, 1872. Rev. Ech., pt. 1, p. 137, 348.

Type, *Lissonotus fragilis* A. Agassiz, 1869. Bull. M. C. Z., 1, p. 273.

This is a well-marked genus of large spatangoids. In the deeply sunken scrobicules of the primary tubercles, it approaches Lovenia and the probability of this relationship is strengthened by certain resemblances in the pedicellariae. It is especially worthy of note that ophicephalous pedicellariae are wanting in both genera. That these two genera are placed in separate families is a striking commentary on the system of classification used, one result of our very imperfect knowledge of spatangoid development. The separation of the species of Homolampas is very difficult. The peripetalous fasciole either tends to disappear with age or else is subject to great individual diversity. There is not sufficient material available to determine such points. After several vain attempts to separate the Homolampas from Indian Seas (*glauca* of Wood-Mason and Alcock) from the Pacific species *fulva*, I have decided to consider them identical. The Panamic and West Indian species are very closely allied to *fulva* as well as

to each other and the differences seem very trivial. The SIBOGA's East Indian species is much better marked, so much so that Mr. Agassiz questioned whether it is really a Homolampas. I have seen no specimens so do not attempt to determine the point, but the pedicellariae do not indicate that any mistake has been made in the generic designation.

Key to the Species of Homolampas.

No anal rostrum.
- Peristome and ambulacrum III in front of it, deeply sunken; width of test .75–.80 length . . . . . *fulva.*
- Peristome and ambulacrum III in front of it, not deeply sunken; width of test .65–.70 length.
  - Peripetalous fasciole indistinct or wanting; margin of base of valves of rostrate pedicellariae, nearly smooth . . . . . *fragilis.*
  - Peripetalous fasciole very distinct; margin of base of valves of rostrate pedicellariae with sharp teeth . . . . . *hastata.*

Anal rostrum present . . . . . *rostrata.*

Homolampas fulva.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 209.

Plate 146, figs. *1–6.*

There are in the ALBATROSS collection specimens of Homolampas from very deep water in the Eastern Pacific which seem to be undoubtedly identical with the species collected by the CHALLENGER farther west at a similar great depth. I cannot find tangible differences between them and the species figured by Wood-Mason and Alcock and fully described and figured in detail by Koehler. It is true that Koehler's figures of the pedicellariae do not agree in details with mine, but his photographs (in this particular case) are not very satisfactory and moreover he had only fragments of a single specimen with which to work. For the present then I must consider *glauca* a synonym of *fulva.*

Pedicellariae in the specimens at hand are very numerous but though greatly diversified in size and form they seem to be all more or less modified tridentate. There are certainly no globiferous and no ophicephalous pedicellariae and what I am calling triphyllous and rostrate are hardly more than forms of the tridentate. All the pedicellariae have moderate stalks and all but the stout tridentate have a well-developed neck. The rostrate pedicellariae (Pl. 146,

fig. *4*) are quite common; the valves (Pl. 146, fig. *1*) are .30–.70 in length, slightly curved and meet only at the tip. The stout tridentate are much larger; the valves (Pl. 146, fig. 5) are .45–1.00 mm. long and correspondingly heavy. The slender tridentate are remarkable for the compression and depth of the blade, which is of course most striking when the blade is very narrow. The valves (Pl. 146, figs. *2*, *3*) vary greatly in length and width; they may be only .30 mm. long with the blade .02–.04 mm. wide but they are usually larger and actually range up to 1.20 mm. long with the blade .10–.15 mm. wide. The depth of the blade commonly exceeds its width. The triphyllous pedicellariae are much like miniature stout tridentate; the valves (Pl. 146, fig. *6*) are about .15 mm. long.

The most perfect of the specimens is 108 mm. long, 85 mm. wide and 38 mm. high. There is no indication of a vertical furrow at the posterior end ("sharp cut immediately above the anal system") such as Mr. Agassiz describes and figures in his CHALLENGER specimen. I think this furrow, however, must have been a case of individual diversity for there is no indication of it in a CHALLENGER cotype in the M. C. Z. collection. It was largely because of the lack of this posterior furrow that Wood-Mason and Alcock considered *glauca* different from *fulva*, but its presence is surely not a characteristic feature of *fulva*. Indeed the form of the test is apparently subject to some diversity for the specimen at hand does not agree with either Agassiz's or Koehler's figure. The position of the apex and the form of the posterior end of the test is as shown in Koehler's figure, but the outline of the anterior end is less evenly convex. One of the dorsal primary spines is unbroken and measures a full 65 mm.

Station 3684. Six hundred miles north of the Marquesas. Bott. temp.? 2463 fms. Gy. yl. glob. oz.

Station 4647. Between Galapagos Islands and Peru. Bott. temp. 35.4°. 2005 fms. Lt. gy. br. glob. oz.

Station 4709. Between Easter Island and Galapagos Islands. Bott. temp. 35.3°. 2035 fms. Glob. oz.

Station 4742. Between the Paumotus and Acapulco, Mexico. Bott. temp. 34.3°. 2320 fms. Fne. lt. gy. glob. oz.

Bathymetrical range, 2005–2463 fms. Extremes of temperature, 35.4°–34.3°.

Nine specimens, eight in fragments.

Homolampas fragilis.

Lissonotus fragilis A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 273.
Homolampas fragilis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 137, 348.

Plate 146, fig. *8*.

This is the West Indian species and has been taken at depths ranging from 300 to 1920 fms. The pedicellariae are not abundant on the available material and show no extreme forms. The rostrate have the margin of the base of the valve (Pl. 146, fig. *8*) smoothish or with very low teeth. The tridentate are not separable into stout and slender. The rostrate valves are .35–.60 mm. long, while in the tridentate they are .20–.70 mm.

Homolampas hastata.

A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 81.

Plate 146, fig. *7*.

This Panamic species has been taken only in depths of 978–1132 fms. The pedicellariae are scarce on the available specimens but such as there are resemble those of *fragilis*. The margin of the base of the valves (Pl. 146, fig. *7*) in the rostrate pedicellariae is, however, provided with quite evident sharp teeth. I have not had sufficient material to enable me to decide whether this is a constant specific character or not.

Homolampas rostrata.

De Meijere, 1902. Tijd. Ned. Dierk. Vereen, (2), **8**, p. 14.

This is the curious species collected by the Siboga, south of the Strait of Makassar, in 299–386 fms.

HEMIASTERIDAE, fam. nov.

This family corresponds to that section of the Spatangidae which Gregory calls the Prymnadetinae. Its one characteristic feature is the entire absence of a true subanal fasciole. There is often a fasciole below the periproct but its relationship is with the peripetalous fasciole, with which it often connects on either side and there is no trace of a subanal plastron. It is by no means certain

that the absence of a subanal fasciole is a fundamental character, for we have already seen that this fasciole tends to disappear with age in Urechinus and we know that this also happens in Spatangus at times. Moreover in Meoma the subanal fasciole tends to disappear and the result resembles the lateroanal fasciole of certain Hemiasteridae.

Pedicellariae in the family are abundant and diversified, but it is difficult to find any features characteristic of the family as a whole. Both Mortensen and Koehler have published many figures of the various forms in different genera, while contributions have also been made by de Meijere and Döderlein. The globiferous pedicellariae, when present, often afford good characters which may even be of generic value, while occasionally good specific characters are to be found in the rostrate and tridentate pedicellariae, and more rarely in the ophicephalous.

Thanks to the careful and extended researches of Mortensen, the genera in this family are now fairly easy to distinguish, so far as the Recent forms are concerned but the Fossil forms need careful revision to determine whether any of them are congeneric with species now living. The types of the genera Pericosmus and Hemiaster are Fossil forms, but I can find no good reason for separating the Recent species from them. The genus Linthia is also based on a fossil species, but I fully agree with Pomel that the Australian spatangoid long known as Linthia does not belong in that genus and is best treated as the type of a new genus Protenaster. I cannot see that the proposed genus Pseudabatus is worthy of separation from Abatus, and I doubt the wisdom of recognizing Tripylus and Tripylaster. Another very dubious genus is Prymnaster, which is based on small specimens, probably immature, of species of Paraster. In Paraster too belongs the Recent species called *Linthia rotundata* by Döderlein. On p. 164 of his report on the echinoderms of the Charcot Expedition, Koehler refers to a genus "Parabatus." I am unable to find any such generic name in use and conclude it must be a slip of the pen.

Key to the Genera of Hemiasteridae.

No fascioles.

Test markedly depressed, v. d. less than .40 length; petals nearly flush . . . *Platybrissus.*

Test moderately high, v. d. more than .50 length; petals (at least in ♀) more or less sunken . . . . . *Amphipneustes.*

Peripetalous fasciole present.

Ambulacra II and IV dorsally, not petaloid and not sunken, the anterior series of pore-pairs wanting . . . . . *Agassizia.*

Ambulacra II and IV dorsally more or less petaloid, or deeply sunken, the anterior series of pore-pairs present.

A marginal fasciole, entirely separate from peripetalous fasciole, present . *Pericosmus.*
No true marginal fasciole.
Abactinal system ethmophract; genital pores 4; no lateroanal fasciole . . . . . *Hemiaster.*
Abactinal system ethmolytic.
Genital pores 4; lateroanal fasciole more or less completely developed, rarely wanting.
Apex subcentral or anterior; anterior petal (III) narrow, not distinctly petaloid and not at all deeply sunken . . . . *Protenaster.*
Apex subcentral or posterior; anterior petal (III) wide, more or less petaloid and deeply sunken.
Ambulacral plates, especially in III, low and numerous . *Paraster.*
Ambulacral plates, especially in III, high and few . . *Prymnaster.*
Genital pores 3 or 2.
Peripetalous fasciole double, rarely triple, anteriorly; test high; genital pores 3 . . . . . *Faorina.*
Peripetalous fasciole single throughout.
Peripetalous fasciole runs across interambulacra 1 and 4 at some distance from apical system, not following closely the margins of petals II and IV.
Petals II and IV divergent, straight, the anterior margin straight or a little convex; petals I and V usually two thirds as long as II and IV or more; ambulacrum III generally little sunken, and when petaloid, not broader than II or IV; apex subcentral.
Ambulacrum III much like the others abactinally; all petals long and little sunken; globiferous pedicellariae terminate in 5 long, slender teeth . . . . . *Parapneustes.*
Ambulacrum III more or less markedly different from the others; petals more or less sunken; globiferous pedicellariae not as above.
Lateroanal fasciole very distinct; petals II and IV do not reach peripetalous fasciole *Tripylus.*
Lateroanal fasciole partial, indistinct or wanting; petals II and IV terminate at peripetalous fasciole . . . . . *Abatus.*
Petals II and IV generally at first little divergent, then becoming more so and at tip usually markedly curved outward so that anterior margin is distinctly convex; petals I and V less than two thirds, often not one fourth of II and IV in length; ambulacrum III usually somewhat petaloid in adults, and often broader and more sunken than the others.
Test low, v.d. usually less than .60 length; genital pores 3.
Apex subcentral or somewhat posterior;

posterior petals relatively long; globiferous pedicellariae with 4 teeth around terminal opening . . . . . *Tripylaster.*

Apex posterior; posterior petals relatively short; globiferous pedicellariae with a single terminal tooth . . . . . *Brisaster.*

Test high, v.d. more than .60 length; genital pores only 2.

Lateroanal fasciole incomplete or wanting; petals not much sunken . . . . . *Hypselaster.*

Lateroanal fasciole complete, distinct; petals especially III more or less deeply sunken.

Ambulacral pores in III in a double series . . . . . *Ova.*

Ambulacral pores in III in a single series . . . . . *Schizaster.*

Peripetalous fasciole follows closely the margins of petals II and IV; all petals very deeply sunken; lateroanal fasciole well marked; genital pores 2.

Petals II and IV longer and wider than III; petals not so deeply depressed as to be enterable only through narrow slits . . . . . *Moiropsis.*

Petals II and IV not longer and wider than III; petals so deeply depressed as to be enterable only through narrow slits . . . . . *Moira.*

Platybrissus.

Grube, 1865. Jahresb. Schles. Gesell. Vat. Cult., **43**, p. 61.

Type, *Platybrissus roemeri* Grube, 1865. *Loc. cit.*

This is a monotypic genus of which almost nothing has been learned since its original description. The specimen of the type species in the M. C. Z. collection is apparently the holotype and so far as I have been able to learn the only other specimen known is one belonging to Döderlein. Unfortunately both specimens are bare tests. There is no clue as to the locality whence the M. C. Z. specimen came, but Döderlein states (1911. Abh. Senckenb. Nat. Gesellsch., **34**, p. 237) that his specimen is from the Banda Sea.

Amphipneustes.

Koehler, 1900. Bull. Acad. Belgique, (3), **38**, p. 817.

Type, *Amphipneustes lorioli* Koehler, 1900. *Loc. cit.*

This originally monotypic genus was based on a single specimen taken by the Belgica in the Antarctic Ocean at a depth of about 334 fms. Subsequently

the Swedish South Polar Expedition secured a specimen of the same species and a series of specimens of a second closely allied form. Finally the Expedition Charcot in 1909 secured a single specimen of what seems to be a third species.

Key to the Species of Amphipneustes.

Periproct on oral surface; test high, v. d. exceeds .60 length.
Petals nearly or quite flush with the test . . . . . *lorioli.*
Proximal portion of paired petals deeply sunken . . . . . *mortenseni.*
Periproct on posterior vertical end of test, not visible from below . . . . . *koehleri.*

Amphipneustes lorioli.

Koehler, 1900. Bull. Acad. Belgique, (3), **38**, p. 817.

This is the BELGICA'S species, taken far down in the Antarctic Ocean below South America, at a depth of 334 fms. The specimen taken by the Swedish Expedition was collected off Graham's Land (directly south of Tierra del Fuego) in 223 fms.

Amphipneustes mortenseni.

Koehler, 1912. Zool. Anz., **39**, p. 162.

The only known specimen of this species was taken near Alexander the First Land (just west of Graham's Land) in 165 fms. by the Expedition Charcot.

Amphipneustes koehleri.

Mortensen, 1905. Vid. Med. f. 1905, p. 243.

A good series of this species was taken by the Swedish South Polar Expedition in the vicinity of South Georgia and near Shag Rock Bank, at a depth of only 42–90 fms.

Agassizia.[1]

Valenciennes, 1846. Voy. Venus. Plates, Zoophytes, **1**, figs. 2–2*f*.
Type, *Agassizia scrobiculata* Valenciennes, 1846. *Loc. cit.*

This is a very well-marked genus, the affinities of which are doubtful. The fascioles have an unusual arrangement which is very characteristic. Pedicellariae seem to be very rare and are not at all distinctive.

[1] Originally spelled Agassisia.

Key to the Species of Agassizia.

Posterior petals well developed, more or less depressed . . . . . *scrobiculata.*
Posterior petals little developed, flush with test . . . . . *excentrica.*

Agassizia scrobiculata.

Valenciennes, 1846. Voy. Venus. Plates, Zoophytes, **1**, figs. 2–2*f*.

This species occurs in shallow water along the western coast of tropical and subtropical America. I have examined a number of good specimens, in search of pedicellariae, but with little success. The only kind found, and that very rarely, is a tridentate, which is not at all distinctive. The valves are .25–.50 mm. long, with the narrow, high base and broad, leaf-shaped blade of about equal length and breadth; the margin of the blade is rather sharply serrate. Apparently the distinctly subarenaceous life has led to gradual loss of the pedicellariae as it has in many clypeastroids.

Agassizia excentrica.

A. Agassiz, 1869. Bull. M. C. Z., **1**, p. 276.

Of this West Indian species there are no specimens except bare tests available, so I am unable to give any information about the pedicellariae.

Pericosmus.

Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), **8**, p. 19.

Type, *Micraster edwardsii* Agassiz, 1840. Cat. Syst. Zool., Ect. 2 (*nomen nudum*), = *Schizaster agassizii* Sismonda, 1841. Mon. Ech. Foss. Piemonte, p. 23.

The discovery of a Recent species of this genus by the Investigator in shallow water on the eastern side of the Bay of Bengal is one of that vessel's many important contributions to marine zoölogy. By an unfortunate typographical error in Koehler's account of the species (1914. Ech. Indian Mus. Spat., p. 133) the longitude of the type locality is made to read 29° 55′ E. instead of 92° 55′ E. This interesting species was called by Anderson, its discoverer, *Pericosmus macronesius*, and Dr. Koehler has retained the name.

Hemiaster.

Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), **8**, p. 16.
Type, *Spatangus bufo* Al. Brongniart, 1882. Cuvier's Oss. Foss., **2**, p. 320, 604.

This is a very ill-defined group of spatangoids. A large number of Fossil species have been referred to it and its exact limits are still uncertain. Some nine Recent species have also been called Hemiaster. The first of these to be described was Lovén's *H. expergitus* and I see no reason to doubt that this is really congeneric with *H. bufo*. Mortensen has shown that *H. mentzii* and *H. gibbosus* of A. Agassiz are identical with *expergitus*, and that Mr. Agassiz's *H. zonatus* is in part *expergitus* and in part an unidentifiable Brisaster. Studer's *H. florigerus* is not a Hemiaster; so far as I can see, it is a Paraster and I have included it in that genus. On the other hand Mr. Agassiz's *Periaster tenuis* is a Hemiaster, as the genus is here restricted. No doubt many of the Fossil species referred to Hemiaster have no right in the genus in this restricted sense.

Key to the Species of Hemiaster.

Petaloid area small, so peripetalous fasciole is not near ambitus.
- Sternum short and wide, its width .65–.85 of its length; test high, v. d. at posterior end .65–.90 length.
  - Height of test .65–.75 length; peristome about .20–.25 of test-length from anterior end . . . . . *expergitus.*
  - Height of test about .90 length; peristome about .30–.32 of test-length from anterior end . . . . . *globulus.*
- Sternum longer and narrower, its width only about half its length or less.
  - Test very high posteriorly, v. d. about .80–.90 length . . . . . *vanus.*
  - Test more flattened, v. d. only .60–.65 length . . . . . *tenuis.*

Petaloid area large and very conspicuous so peripetalous fasciole is close to ambitus . . *hickmani.*

Hemiaster expergitus.

Lovén, 1871. Öfv. Vet. Akad. Förh., no. 8, p. 6, fig. (*desc. impar*). 1874. Études sur les Éch., p. 13.

I have nothing to add to Mortensen's extensive account of this species (1907. Ingolf Ech., pt. 2, p. 97–103). The large series in the Albatross collection confirms his opinion that *gibbosus* cannot be distinguished from *expergitus*, and there is no advantage in attempting to maintain it, as he suggests, as a "variety" merely because it occurs in the western Pacific instead of the Atlantic.

Station 2751. West of Montserrat, B. W. I. Bott. temp. 40°. 687 fms. Bu. glob. oz.

Station 4913. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4967. Between Kobe and Yokohama, Japan. Bott. temp. 45.9°. 244–253 fms. Br. m., s., for.

Station 4968. Between Kobe and Yokohama, Japan. Bott. temp. 45.7°. 253 fms. Dk. gy. s., br. m., brk. sh.

Station 4970. Between Kobe and Yokohama, Japan. Bott. temp. 39.1°. 500–649 fms. Br. m., bk. s., sh.

Station 4971. Between Kobe and Yokohama, Japan. Bott. temp. 38.1°. 649 fms. Br. gn. m., for.

Station 4973. Between Kobe and Yokohama, Japan. Bott. temp. 38.2°. 600 fms. Br. m., st.

Station 4977. Between Kobe and Yokohama, Japan. Bott. temp. 38.9°. 544 fms. Br. m., fne. s.

Station 5053. Suruga Gulf, Japan. Bott. temp. 34.9°. 503 fms. Gn. m.

Station 5054. Suruga Gulf, Japan. Bott. temp. 45.3°. 282 fms. Gn. m., brk. sh.

Station 5056. Suruga Gulf, Japan. Bott. temp. 46°. 258 fms. Gn. m., brk. sh., for.

Station 5083. Off Omai Saki Light, Japan. Bott. temp. 38.1°. 624 fms. Fne. gy. s., glob.

Station 5086. Sagami Bay, Japan. Bott. temp. 43.7°. 292 fms. Gn. m., crs. bk. s.

Station 5087. Sagami Bay, Japan. Bott. temp. 37.5°. 614 fms. Gn. m.

Station 5088. Sagami Bay, Japan. Bott. temp. 41.8°. 369–405 fms. Gn. m.

Station 5093. Off Gulf of Tokyo, Japan. Bott. temp. 43.9°. 302 fms. Crs. bk. s.

Bathymetrical range, 244–687 fms. Extremes of temperature, 46°–34.9°. Fifty-six specimens.

Hemiaster globulus.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **51**, p. 135.

Plates 146, fig. *11*; 150, fig. *5*; 154, figs. *7–10*.

Length 36 mm.; width 35 mm.; height at posterior end 33 mm.; height at anterior end, about 20 mm. The ambitus is nearly circular except at the posterior end where it is slightly flattened. The general form of the test is

so well shown on Plate 154 that no further description is necessary. The peripetalous fasciole is nearly or quite 3 mm. wide at the ends of the petals and about 2 mm. wide at the middle of each interambulacrum, but on the boundaries between ambulacra and interambulacra it is only 1 mm. in width. The area it encloses is 23 × 17 mm. The posterior petals are nearly 6 mm. long and almost half as wide; there are about a dozen pore-pairs on each side. Petals II and IV are about 10 mm. long by 3 mm. wide and have 21–23 pore-pairs on each side. Ambulacrum III is distinctly sunken within the fasciole; the petaloid portion is 13 mm. long by 2 mm. wide, with 21 or 22 pore-pairs on a side, and does not reach the fasciole by about a millimeter. The abactinal system is very compact and it is difficult to make out the sutures. The four genital pores are very distinct but the ocular pores especially the posterior pair are hard to make out. The madreporic genital (2) extends backward further than in *H. expergitus* and distinctly separates the posterior genitals, 1 and 4, but oculars I and V remain in contact. A step further and we should have such a system as that shown in Pl. 150, fig. *4*, where the oculars I and V are separated but the madreporic genital is not long enough to reach them. It would be but a slight step further to a distinctly ethmolytic system such as occurs in most of the family.

The periproct is very small, nearly circular, 3.5 mm. in diameter, and situated high up on the posterior end of the test; its upper margin is scarcely 6 mm. below the crest. All the actinal tube-feet are rather large but 5–6 at the lower, posterior angle of the test are noticeably big. The sternum is about 14 mm. long by 13 mm. wide posteriorly and is densely covered with primary spines, all of which are broken. The peristome is about 6 mm. wide by 4 mm. long, and its anterior margin is nearly 11 mm. from the front of the test. The plates around the peristome (Pl. 150, fig. *5*) are closely united to each other and have also suffered injury so that it is difficult to be sure of their arrangement but apparently the ambulacral plates I*b*1 and 2 and II*a*1 and 2, and IV*b*1 and 2 and V*a*1 and 2 are in contact so that interambulacra 1 and 4 are shut off from the peristome. This is a striking difference from the condition in *expergitus* but I am not sure that it is really the condition in *globulus*.

The test is thickly covered with a fairly uniform coat of slender spines about 2 mm. long, slightly spatulate at the end. On interambulacra 2 and 3 dorsally, within the fasciole, on the sternum and around the mouth the primary spines are much larger. Pedicellariae are relatively rare. Ophicephalous pedicellariae are fairly common at the anterior end of the test but not elsewhere. The stalks are 4–5 times as long as the heads. The valves (Pl. 146, fig. *11*) are about

.22 mm. long, besides the loop which is .05–.08 mm. more; the blade is longer than in the corresponding pedicellariae of *expergitus*. I could find no globiferous or rostrate pedicellariae in *globulus* and only one tridentate. This one is very small, the valves only .15 mm. long., and might perhaps be called a triphyllous; the blade is pointed, somewhat flattened and has finely serrate margins. The color of *globulus* is light brown.

This is a fine, well-characterized species, differing from *expergitus* in the form of the test, the position of the peristome, the shape of the sternum and the character of the pedicellariae. The shape of the petals is also different and it is possible that the arrangement of the plates around the peristome may yield an important specific character. It will be noted that this unique specimen was taken in much shallower water than any specimens of *expergitus*.

Station 4832. Between Nanao and Tsuruga, Hondo, Japan. Bott. temp. 53.2°. 76–79 fms. Dk. gy. s.

Hemiaster vanus.

Koehler, 1914. Ech. Indian Mus. Spat., p. 152.

This is a large species of the Indian Ocean taken by the INVESTIGATOR three times at depths of 836–1310 fms. Only a single complete specimen is known.

Hemiaster tenuis.

Periaster tenuis A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 82.
Hemiaster tenuis Mortensen, 1907. INGOLF Ech., pt. 2, p. 106.

As pointed out by Mortensen, the absence of a lateroanal fasciole and the distinctly ethmophract abactinal system necessitate placing this species in Hemiaster. The pedicellariae have been fully discussed and figured by Mortensen. The species was known only from off Galera Point, Ecuador, in 1573–1772 fms. but fragments are in the ALBATROSS collection from the following stations further south.

The bathymetrical range is very striking.

Station 4651. Off Aguja Point, Peru, 111 miles. Bott. temp. 35.4°. 2222 fms. Fne. stk. gy. m.

Station 4653. Off Aguja Point, Peru, 17 miles. Bott. temp. 41.3°. 536 fms. Dk. br. vol. m.

Hemiaster hickmani.

Koehler, 1914. Ech. Indian Mus. Spat., p. 142.

This is another of the INVESTIGATOR'S discoveries and is the most unmistakable member of the genus. It was taken in considerable numbers in the Gulf of Oman at depths of 689–833 fms.

Protenaster.

Pomel, 1883. Class. Meth. Ech., p. 36.

Type, *Desoria australis* Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 132.

Pomel was quite right in separating the Recent Australian spatangoid called *Desoria australis* by Gray from the Fossil Echini of the genus Linthia. Gray's name Desoria being preoccupied cannot be used and Mr. Agassiz therefore put the species into the closely related genus Linthia. But unfortunately the type of Linthia and the Australian species disagree in some very important points and it is therefore unwise to treat them as congeneric. Protenaster seems to be a rare genus except in the form of bare tests. I have never seen a specimen in any other condition.

The second species of the genus is known only from the bare test of the holotype. Although obviously different from the Australian species, it seems to be more nearly related to it, than to any other spatangoid. The Red Sea spatangoid, called by Mazzetti (1894. Mem. Reg. Accad. Modena, (2), **10**, p. 221) *Linthia assabensis* is unidentifiable. The specimen was only 19 mm. long and Mazzetti makes no reference to any genital pores. I think probably it was a young individual of some of the Schizaster-like spatangoids.

Key to the Species of Protenaster.

Apex anterior; petals II and IV so divergent as to run at nearly right angles to the longitudinal axis of the test; periproct not visible from oral side . . . . . *australis.*

Apex subcentral; petals II and IV much less divergent; periproct overhung by posterior end of test and plainly visible from oral side . . . . . *rostratus.*

Protenaster australis.

Desoria australis Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 132.
Protenaster australis Pomel, 1883. Class. Meth. Ech., p. 36.

This is the Australian species, known only from Tasmania and the southern coast of the continent. It seems to be a littoral species but specimens with spines on are very rare.

Protenaster rostratus.

Linthia rostrata Smith, 1878. Ann. Mag. Nat. Hist., (5), **1**, p. 67.

The unique holotype of this species is a bare test from an unknown locality, supposed to be in the Pacific.

Paraster.

Type, *Schizaster gibberulus* Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), **8**, p. 22.

In his skilful handling of the genus Schizaster, Mortensen (1907. Ingolf, Ech. pt. 2, p. 108–123) has laid all students of Echini under great obligation, but the groups which he considers subgenera seem worthy of generic rank, and even wider separation between Paraster and the others is desirable. In addition to the two species which Mortensen places in this genus, I put Döderlein's *Linthia rotundata* and Studer's *Hemiaster florigerus* here, and Koehler has added a fifth species from Indian seas. I am very much in doubt whether *savignyi* is a valid species but have not the necessary material to determine whether it is really different from *gibberulus*.

Key to the Species of Paraster.

Lateroanal fasciole present.
- Actinal primary tubercles small, numerous and more or less crowded, there being 200± on the sternum.
  - Test high, v. d. posteriorly .70 length or more.
    - Anterior end of test much lower than posterior; ambulacrum III deeply sunken at ambitus . . . . . *gibberulus.*
    - Anterior end of test about as high as posterior; ambulacrum III not deeply sunken . . . . . *rotundatus.*
  - Test lower, v. d. .65 length or less, sloping anteriorly from abactinal system but not so markedly as in *gibberulus* . . . . . *savignyi.*
- Actinal primary tubercles large and relatively few, 100 or fewer on sternum of test 19 mm. long; tuberculated area of sternum about .75 as wide as long . . . . *compactus.*

No lateroanal fasciole . . . . . *florigerus.*

Paraster gibberulus.

Schizaster gibberulus Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), **8**, p. 22.
Paraster gibberulus Pomel, 1869. Revue Ech., p. xiv.

Fourtau (1904, Bull. Inst. Égypt., (4), **4**, p. 434–436) and Koehler (1914. Ech. Indian Mus. Spat., p. 172–180) have thrown much light on this hitherto

imperfectly known species, but we are still greatly in the dark in regard to its growth-changes and the amount of individual diversity which may occur. It is known as yet only from the Red Sea.

Paraster rotundatus.

Linthia rotundata Döderlein, 1906. Valdivia Ech., p. 249.

This species is based on two specimens of small size from Chatham Island, Galapagos. They have so little in common with *Linthia australis*, it is difficult to see why Döderlein placed them in that genus. On the other hand it is not very easy to decide their generic affinities. The globiferous pedicellariae are characteristic and unlike those of any of the species of Schizaster (*sens. lat.*), but are much like those of Prymnaster, as figured by Koehler; their essential structure, however, is not unlike that of the corresponding pedicellariae in Paraster. There are four genital pores and the lateroanal fasciole is well developed in the two specimens, so they may for the present be considered Parasters. The relative importance to give in the Hemiasteridae to the number of genital pores, the presence or absence of a lateroanal fasciole, the structure of ambulacrum III and the character of the globiferous pedicellariae is still undetermined, and until that is at least substantially settled the proper generic position of this species must remain in doubt.

Paraster savignyi.

Schizaster savignyi Fourtau, 1904. Bull. Inst. Égypt., (4), **4**, p. 436.
Schizaster (Paraster) savignyi Mortensen, 1907. Ingolf Ech., pt. 2, p. 122.
Paraster savignyi Koehler, 1914. Ech. Indian Mus. Spat., p. 172.

In spite of Fourtau's opinion, I doubt whether this form, also from the Red Sea, is anything more than a variety of the preceding, but having no evidence, I defer to his assertion that it is distinct. There is in the M. C. Z. collection a fine specimen of a Paraster labeled: "Schizaster jukesii Gray. Feejee Islands. Godeffroy Mus. Orig. No. 6256." This specimen is 67 mm. long, 60 mm. wide and 42 mm. high. The apical system is 35 mm. from the anterior end, and the test slopes markedly from it to the front. So far as I can see this individual agrees well with Fourtau's and with Koehler's descriptions and figures of *savignyi*. But the locality arouses suspicions.

Paraster compactus.

Koehler, 1914. Ech. Indian Mus. Spat., p. 180.

Based on three small, damaged specimens, without spines or pedicellariae, the status of this species must be considered dubious. The fact that two of the specimens were from only 20 fms. on the coast of Madras, while the third and best preserved was from 599 fms. in the Bay of Bengal is worthy of special note.

Paraster florigerus.

Hemiaster florigerus Studer, 1880. Monatsb. Berlin Akad. Wiss., p. 882.

This species is based on a single, small (24 mm. long) individual, from an unrecorded locality. The absence of a lateroanal fasciole is a serious obstacle to placing it in Paraster but in view of our ignorance concerning the form it may remain here for the present.

Prymnaster.

Koehler, 1914. Ech. Indian Mus. Spat., p. 187.
Type, *Prymnaster angulatus* Koehler, 1914, *op. cit.*, p. 188.

It is difficult to avoid the feeling that this genus is based on a growth-stage of Paraster, but since so careful and skilled a zoölogist as Dr. Koehler vouches for it, it must for the present be accepted.

Key to the Species of Prymnaster.

Width of test .80–.90 of length; height .65–.80 length . . . . . *angulatus.*
Width of test .80 of length; height less than .60 length . . . . . *investigatoris.*

Prymnaster angulatus.

Koehler, 1914. Ech. Indian Mus. Spat., p. 188.

This species is based on thirteen specimens, of which the largest is only 20 mm. long. They were taken by the Investigator in the Laccadive Sea in 56–58 fms.[1]

[1] By an unfortunate misprint the station is given by Koehler as 247 and the latitude as 27° N. From the context it is possible to determine that the station was 242 and the latitude 17° 27′ N.

Prymnaster investigatoris.

Koehler, 1914. Ech. Indian Mus. Spat., p. 196.

This species is based on a single specimen, 15 mm. long, from Port Blair, Andaman Islands. Koehler is himself doubtful as to its being a Prymnaster.

Faorina.

Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 132.
Type, *Faorina chinensis* Gray, 1851, *loc. cit.*

This is one of the genera of which all the specimens available to me are bare tests, but Koehler has so fully described the spines, pedicellariae, and internal anatomy (1914. Ech. Indian Mus. Spat., p. 129) that the gaps in our knowledge of the type species, the only Recent form, are now well filled. Originally known only from Shanghai and Hong Kong, this species was taken by the SIBOGA in the Flores Sea, and the INVESTIGATOR has found it to be common in the Gulf of Martaban, Burmah, and near the Andaman Islands.

Parapneustes.

Koehler, 1912. Zool. Anz., **39**, p. 161.
Type, *Parapneustes cordatus* Koehler, 1912, *loc. cit.*

This is an Antarctic group nearly related to the long and well-known genera Tripylus and Abatus. The genus has been met with only by the Expedition Charcot and then only twice. The two specimens taken appear to represent different species, which are fully described and figured by Koehler in his report on the Echinoderms collected by the POURQUOI-PAS (1912. Ech. Exp. Charcot, p. 164–175).

Key to the Species of Parapneustes.

V. d. less than half length; test abruptly narrowed posteriorly . . . . . *cordatus.*
V. d. .60 test-length; test not abruptly narrowed posteriorly . . . . . *reductus.*

Parapneustes cordatus.

Koehler, 1912. Zool. Anz., **39**, p. 161.

The unique holotype of this species was taken west of Alexander the First Land in 256 fms. Other specimens were taken but were too badly crushed to be of any value.

Parapneustes reductus.

Koehler, 1912. Zool. Anz., **39**, p. 162.

A single specimen of this species was secured in 212 fms. near Graham's Land.

Tripylus.

Philippi, 1845. Arch. f. Naturg., 11, **1**, p. 344.
Type, *Schizaster (Tripylus) excavatus* Philippi, 1845, *loc. cit.*

Mortensen's restoration of this genus seems possibly justifiable even though it is very near to the following. The only known species occurs along the coast of southern South America, at least on the west side, but there has been so much confusion between the various species of Abatus, Tripylus, and Tripylaster that the exact limits of the distribution of Tripylus is still uncertain. The latest information on the genus is given by Mortensen (1910. Swedish South Polar Exp. Ech., p. 87–89).

Tripylus excavatus.

Schizaster (Tripylus) excavatus, Philippi, 1845. Arch. f. Naturg., 11, **1**, p. 344.
Tripylus excavatus Troschel, 1851. Arch. f. Naturg., 17, **1**, p. 67, 72.

There is a single specimen, a fine nearly bare test, in the ALBATROSS collection. It is 44 mm. long, 44 mm. wide and 25 mm. high. The color is pale pinkish purple above and nearly white beneath, with the fascioles standing out in deep pink-purple. The species is known only from Chile and the Strait of Magellan. The small specimens recorded in the HASSLER Echini from off Cape Corrientes, Argentina, prove to be *Abatus cavernosus*.

Station 2777. Strait of Magellan. Bott. temp.? 20 fms. G.

Abatus.

Troschel, 1851. Arch. f. Naturg., 17, **1**, p. 72.
Type, *Schizaster (Tripylus) cavernosus* Philippi, 1845. Arch. f. Naturg., 11, **1**, p. 345.

This genus has been thoroughly worked over in recent years by Mortensen and Koehler. Mortensen has succeeded admirably in untangling the snarl into which the early descriptions had gotten and has brought out clearly the differences between Abatus and Hemiaster, and also those which distinguish the species of the former genus. Koehler has added three new species to the

four old ones which had been straightened out by Mortensen, but I cannot avoid the feeling that my honored French colleague allows little room for individual diversity.

Key to the Species of Abatus.

Modified or sunken portion of paired petals begins close to abactinal system.
- Width of test .85 of length or usually much more.
  - 3–6 pairs of tube-feet near periproct enlarged, penicillate; petals II and IV diverging from long axis of test by an angle of only 45°–50°.
    - Petals I and V as wide as II and IV; in female all 4 are deeply sunken . . *cavernosus.*
    - Petals I and V are distinctly narrower than II and IV, only the latter sunken in female . . . . . *philippii.*
  - Tube-feet near periproct not enlarged or 1, 2 and rarely 3 pairs may be; petals II and IV diverging from long axis of test by an angle of 60°–70°.
    - Ambulacrum III deeply sunken dorsally; anterior margin of test correspondingly notched; petals about equal . . . . . *cordatus.*
    - Ambulacrum III not sunken; anterior margin of test not notched; petals I and V may be longer than II and IV.
      - Apical system central; peripetalous fasciole, especially anteriorly, not near ambitus . . . . . *agassizii.*
      - Apical system anterior; peripetalous fasciole, especially anteriorly approaches nearly or quite to ambitus . . . . . *shackletoni.*
- Width of test only .80 of length . . . . . *koehleri.*

Modified or sunken portion of paired petals begins only some 8 or 9 pore-pairs distant from abactinal system . . . . . *nimrodi.*

Abatus cavernosus.

Schizaster (Tripylus) cavernosus Philippi, 1845. Arch. f. Naturg., 11, **1**, p. 345.
Tripylus (Abatus) cavernosus Troschel, 1851. Arch. f. Naturg., 17, **1**, p. 72.
Abatus cavernosus Lovén, 1883. On Pourtalesia, p. 25.

This is the characteristic species of the southern part of South America and of the neighboring islands. It is known from South Georgia and Juan Fernandez and probably occurs at the Falkland Islands also. There are specimens in the M. C. Z. from as far north as Cape Corrientes and "off La Plata." The types of *Spatagodesma diomedeae* are very young specimens of this species, as Mortensen has suggested.

Abatus philippii.

Lovén, 1871. Öfv. Vet. Akad. Förh., no. 8, p. 6, fig. (*desc. impar*).
Mortensen, 1910. Swedish South Polar Exp. Ech., p. 83

Lovén's account of this species is totally inadequate and only Mortensen's work justifies the use of the name. Moreover it is quite possible that this so-

called species is only a form of *cavernosus* due to youthfulness, my impression being that the females when first breeding have only the anterior petals depressed but later in life all four petals are used as brood-pouches. I have not sufficient material at hand to feel sure however. There are no specimens in the M. C. Z. collection and the specimens before me from the ALBATROSS collection are neither large enough nor numerous enough to meet the need. But the largest (35 mm. long) has all four petals (I, II, IV, V) equally but not greatly depressed, while a smaller specimen (28 mm. long) has II and IV very greatly depressed, I not quite so deep and V only a little sunken. The fact that *philippii* is found along the east coast of Argentina, where *cavernosus* also occurs seems to strengthen the suspicion against the validity of Lovén's species.

Station 2769. Off Cape Dos Bahios, Argentina. Bott. temp. 56.6°. 51.5 fms. Gn. m., fne. s.

Twelve specimens.

Abatus cordatus.

Hemiaster cordatus Verrill, 1876. Bull. 3, U. S. Nat. Mus., p. 69.
Abatus cordatus Studer, 1876. Monatsb. Berlin Akad. Wiss., p. 457.

This species is known as yet only from Kerguelen Island.

Abatus agassizii.

Mortensen, 1910. Swedish South Polar Exp. Ech., p. 86.

This species is known only from South Georgia. Two specimens in the M. C. Z. collection are from unknown localities. One was purchased in Hamburg. There are no other specimens in the M. C. Z. so that Mortensen's supposition (*op. cit.* p. 87) that we have material from the Patagonian coast is a mistake.

Abatus shackletoni.

Koehler, 1911. British Antarctic Exp. Biol., **2**, pt. 4, p. 51.

This species is based on a dozen specimens from Cape Royd's Bay, Antarctica (south of New Zealand), where it is geographically quite isolated, especially from *agassizii*, the species to which it seems nearest.

Abatus koehleri.

Hemiaster elongatus Koehler, 1907. Zool. Anz., **32**, p. 147 (preoccupied).
Hemiaster koehleri Thiéry, 1909. Rev. Crit. Pal., **13**, p. 137.
Abatus elongatus Mortensen, 1910. Swedish South Polar Exp. Ech., p. 87.

This species, which may perhaps be identical with *agassizii*, is based on four specimens from Scotia Bay, South Orkneys. It is a little odd that not only Mortensen (1910) but Koehler himself (1911) overlooked Thiery's correction of the name.

Abatus nimrodi.

Pseudabatus nimrodi Koehler, 1911. British Antarctic Exp. Biol., **2**, pt. 4, p. 60.

Although Koehler himself considers this form well enough marked to be the type of a new genus, I must confess that until all the growth-stages of *shackletoni* are known, I shall be unable to accept such a conclusion. Indeed, the pedicellariae seem to be the best reason for considering *nimrodi* a different species from *shackletoni*, which occurs at the same location. The only two known specimens of *nimrodi* are from Cape Royd's Bay, Antarctica.

Tripylaster.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 122.
Type, *Tripylus philippii* Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 132.

As Mortensen has pointed out (1910. Swedish South Polar Exp. Ech., p. 69) this genus seems to be intermediate between Abatus and Brisaster. Indeed the difference from the latter is so slight, I hesitate to accept the genus. But for the present, there seems no better course.

Tripylaster philippii.

Tripylus philippii Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 132.
Schizaster (Tripylaster) philippii Mortensen, 1907. Ingolf Ech., pt. 2, p. 122.

Plate 155, figs. *7*, *9*.

As this species has been long known from both sides of Patagonia, and has been studied and described by a number of writers, there is nothing to add. But two photographs of an unusually perfect bare test are given for the

purpose of comparison with allied forms. The ALBATROSS series consists of specimens from 32 to 62 mm. in length.

Station 2769. Off Cape Dos Bahios, Argentina. Bott. temp. 56.6°. 51.5 fms. Gn. m., fne. s.

Station 2771. Near Port Gallegos, Argentina. Bott. temp. 49.4°. 50.5 fms. Gy. s., bl. sp.

Station 2778. Straits of Magellan. Bott. temp. 47.9°. 61 fms. Gy. s., bl. sp.

Station 2779. Straits of Magellan. Bott. temp. 46.9°. 77.5 fms. Gn. oz.

Bathymetrical range, 50.5–77.5 fms. Extremes of temperature, 56.6°–46.9°.

Nine specimens.

Brisaster.

Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 61.

Type, *Brissus fragilis* Düben and Koren, 1846. Skan. Ech., p. 280.

This group seems quite entitled to recognition and I do not hesitate to give it full generic rank. The species, however, are not sharply defined and I find it difficult and occasionally impossible to distinguish all the forms that have been named. Both Mortensen and Döderlein consider Studer's species *capensis* as at least a recognizable variety of *fragilis* but in this I cannot follow them. I am unable to find any good reason for using Studer's name and am obliged further to maintain that Döderlein's species *antarcticus* cannot be recognized. On the other hand, the form which in the CHALLENGER Report is called *ventricosus* is probably identical with *latifrons*, the true *ventricosus* Gray being the same as *Schizaster lacunosus* (L.). Mortensen first pointed this out in his full discussion of the genus Schizaster (1907, INGOLF Ech., pt. 2). On the other hand, one of the CHALLENGER specimens from Kerguelen, labeled *moseleyi*, has led to the conclusion that two species are confused under that name, and I have accordingly given the name *kerguelenensis* to the island form.

Key to the Species of Brisaster.

Lateroanal fasciole complete, rarely broken on one side, very rarely on both.

Ambulacrum III moderately wide, the width of petal III at its anterior end about ⅓ its length or less; the other petals rather narrow and not truncate at tip . . *fragilis.*

Ambulacrum III wide, the width of petal III at its anterior end about ½ its length; the other petals broad, truncate at tip by the very wide peripetalous fasciole . *indicus.*

Lateroanal fasciole reduced to only a slender piece below periproct, or entirely wanting.
Petals very large occupying most of upper surface of test, all nearly as wide as III; I and V half as long as II and IV or longer; greatest width of test in front of middle . . . . . *townsendi.*
Petals smaller and narrower; I and V usually $\frac{1}{3}$ of II and IV but sometimes more; greatest width of test at or back of middle.
Sternum not twice as long as wide.
Petal III very wide, $\frac{1}{3}$–$\frac{1}{2}$ its own length; anal fasciole distinct; v. d. not $\frac{1}{2}$ length . . . . . *latifrons.*
Petal III not so wide, about $\frac{1}{4}$ its own length; anal fasciole wanting or faint; test distinctly elevated at apex, v. d. often far more than $\frac{1}{2}$ length . . . . . *moseleyi.*
Sternum nearly 3 times as long as wide; v. d. not $\frac{1}{2}$ length. . . . . *kerguelenensis.*

Brisaster fragilis.

Brissus fragilis Düben and Koren, 1846. Skan. Ech., p. 280.
Schizaster (Brisaster) fragilis Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 61.

This is the well-known species of the Atlantic Ocean, but its distribution is very peculiar. On the American coast it extends as far south as Florida at depths in excess of 35 fms., but on the European coast it is not known south of the Faeroe Channel. Yet it occurs in the region of the Cape of Good Hope! I have at hand one of the CHALLENGER specimens from that region and in spite of Mortensen's and Döderlein's critical notes, I am unable to believe that it differs from *fragilis*, the suggested distinctions being either too trivial or too inconstant.

Brisaster indicus.

Koehler, 1914. Ech. Indian Mus. Spat., p. 201.

Since this species is based on four very small specimens, 10 or 11 mm. long, it is obvious that its real status is uncertain, but in view of its geographical isolation at the Andaman Islands, it is probably a valid form.

Brisaster townsendi.

Schizaster townsendi A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 82.
Schizaster (Brisaster) townsendi Mortensen, 1907. INGOLF Ech., pt. 2, p. 123.

Plate 155, figs. *4*, *6*, *8*.

As Mortensen has examined the pedicellariae of this species, it is unnecessary to give any account of them. The large series of specimens in the ALBA-

TROSS collection ranges in length from 10 to 64 mm. The largest is rather wider than long and is only 31 mm. high. There is considerable individual diversity not only in the shape of the test but in the length and width of the petals, especially the posterior pair. As a rule the specific characters are well shown, but there is undoubtedly a tendency to intergrade with *latifrons*, and possibly hybridization with that species occurs. The following list of stations extends the known range of the species far to the north, as it was previously recorded only from southern California to the Galapagos Islands.

Station 2890. Off Oregon. Bott. temp. 42.2°. 277 fms. Gy. s.

Station 2891. Off southern California. Bott. temp. 45.1°. 233 fms. M.

Station 2892. Off southern California. Bott. temp. 44.1°. 284 fms. Yl. m.

Station 2909. Off southern California. Bott. temp. 45.2°. 205 fms. Gn. m.

Station 2925. Off southern California. Bott. temp. 42.9°. 339 fms. M.

Station 2980. Off southern California. Bott. temp. 38.9°. 603 fms. Gn. m.

Station 3073. Off Washington. Bott. temp. 49.2°. 477 fms. Gn. m.

Station 3076. Off Washington. Bott. temp. 43.4°. 178 fms. Gn. m.

Station 3077. Off southeastern Alaska. Bott. temp. 42.4°. 322 fms. Gn. m., g.

Bathymetrical range, 68–603 fms. Extremes of temperature, 49.2°–38.9°.

Two hundred and thirty-two specimens.

Brisaster latifrons.

Schizaster latifrons A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 81.
Schizaster (Brisaster) latifrons Mortensen, 1907. INGOLF Ech., pt. 2, p. 123.

This is another Panamic species whose range is enormously extended by the large series in the ALBATROSS collection. And it must be added that the specimens from Japan, recorded in the CHALLENGER Report as *Schizaster ventricosus* Gray seem to be identical with this wide-ranging form. Mr. Agassiz's original material of *latifrons* was scanty and the specimen on which the species was based was only 17 mm. long. But the more abundant material which has since been collected shows that the supposedly specific characters are in part at least due to immaturity, so that while the species is probably valid the name *latifrons* is not particularly appropriate except to young specimens. Some of

the Japanese specimens are very large, measuring 70–75 mm. long and these often approach very nearly to *townsendi* in the size and form of the petals, a notable case of parallelism. The form of the test in these specimens shows much diversity; one is 75 mm. long, 64 mm. wide and 35 mm. high, while another from the same station is 72 mm. long, 67 mm. wide and 34 mm. high. My earlier statement that this species "seems to have a more restricted range" (1913. Bull. Amer. Mus. Nat. Hist., **32**, p. 225) than *B. townsendi* is obviously not borne out by the following list of stations where the ALBATROSS has taken it.

Station 2882. Off Oregon. Bott. temp. 45.8°. 68 fms. Gy. s.

Station 2923. Off southern California. Bott. temp. 39°. 822 fms. Gn. m.

Station 2974. Off southern California. Bott. temp. 53.2°. 73 fms. Gn. m.

Station 3067. Off Washington. Bott. temp.? 82 fms. Gn. m.

Station 3697. Off Manazuru Zaki, Japan. Bott. temp.? 120–265 fms. Gy. m., vol. s.

Station 3709. Off Shimizu Harbor, Japan. Bott. temp.? 173–260 fms. Stf. bl. vol. m., r.

Station 3737. Entrance to Port Heda, Japan. Bott. temp.? 161–167 fms. Gn. m., vol. s.

Station 3771. Off Doumiki Saki, Japan. Bott. temp.? 61 fms. Gn. m., s.

Station 3772. Off Kinkwasan Light, Japan. Bott. temp.? 79 fms. Gn. m., s.

Station 3775. Off Kinkwasan Light, Japan. Bott. temp.? 57 fms. Gn. m., s.

Station 3784. North of the Aleutian Islands. Bott. temp.? 850 fms. Gn. m., fne. gy. s.

Station 4194. Halibut Bank, Gulf of Georgia. Bott. temp. 48.3°. 111–170 fms. Sft. gn. m.

Station 4197. Halibut Bank, Gulf of Georgia. Bott. temp. 46.8°. 31–90 fms. Stk. gn. m., fne. s.

Station 4198. Halibut Bank, Gulf of Georgia. Bott. temp. 46.8°. 157–230 fms. Sft. gn. m.

Station 4201. Off Fort Rupert, Vancouver Island, B. C. Bott. temp. 45.5°. 138–145 fms. Sft. gn. m., s., br. sh.

Station 4229. Vicinity of Naha Bay, Behm Canal, Alaska. Bott. temp. 42.6°. 198–256 fms. Sft. gy. m.

Station 4235. Vicinity of Yes Bay, Behm Canal, Alaska. Bott. temp. 42.8°. 130–193 fms. Gy. m., bl. sp.

Station 4251. Stephens Passage, Alaska. Bott. temp. 40.9°. 198 fms. Rky.

Station 4748. Off Bushy Point, Alaska. Bott. temp.? 185–300 fms. M., sh.

Station 4768. On Bowers Bank, Bering Sea. Bott. temp. 37°. 764 fms. Gn-br., m., fne. bk. s.

Station 4775. On Bowers Bank, Bering Sea. Bott. temp.? 584 fms. Gn. m., bk. sp., for.

Station 4832. Off Ando Zaki, Japan. Bott. temp. 53.2°. 76–79 fms. Dk. gy. s.

Station 4842. Off Dogo Island, Japan. Bott. temp. 54.6°. 82 fms. Fne. gn. s., sh.

Station 4968. Off Shio Misaki Light, Japan. Bott. temp. 45.7°. 253 fms. Dk. gy. s., br. m., brk. sh.

Station 4993. Off north end of Rebun To, Japan. Bott. temp. 35.1°. 142 fms. Gy. m., s., gr.

Station 5015. Off southeastern Saghalin. Bott. temp. 35.9°. 510 fms. Gn. m.

Station 5029. In the Okhotsk Sea. Bott. temp. 35.3°. 440 fms. Bk. s., gr.

Station 5032. In Yezo Strait, Japan. Bott. temp. 34.9°. 300–533 fms. Br. m., fne. bl. s., gr.

Station 5033. In Yezo Strait, Japan. Bott. temp. 35.9. 533 fms. Gn. m., fne. bl. s.

Station 5036. Off Urakawa Light, Hokkaido, Japan. Bott. temp. 37.9°. 464 fms. Br. m.

Station 5037. Off Urakawa Light, Hokkaido, Japan. Bott. temp. 37.9°. 175–349 fms. Bott.?

Station 5039. Off south coast of Hokkaido, Japan. Bott. temp. 37.9°. 269–326 fms. Gn. m.

Station 5040. Off south coast of Hokkaido, Japan. Bott. temp. 37.1°. 140–269 fms. Gn. m.

Station 5045. Off south coast of Hokkaido, Japan. Bott. temp. 38°. 359 fms. Br. m., fne. bk. s., co., s.

Station 5046. Off Kinka San Light, Japan. Bott. temp. 50.8°. 82 fms. Dk. gy. s., p.

Station 5047. Off Kinka San Light, Japan. Bott. temp. 49.6°. 107 fms. Dk. gy. s., brk. sh., p.

Station 5049. Off Kinka San Light, Japan. Bott. temp. 37.8°. 182 fms. Dk. gy. s., brk. sh., for.

Station 5051. Off Kinka San Light, Japan. Bott. temp. 38.1°. 399 fms. Dk. gy. s., brk. sh., for.

Station 5053. Off Omai Saki Light, Japan. Bott. temp. 34.9°. 503 fms. Gn. m.

Station 5054. Off Omai Saki Light, Japan. Bott. temp. 45.3°. 282 fms. Gn. m., brk. sh., for.

Station 5055. Off Omai Saki Light, Japan. Bott. temp. 56.6°. 124 fms. Gn. m., gy. s., brk. sh., p.

Station 5056. Off Ose Saki, Japan. Bott. temp. 46°. 258 fms. Gn. m., brk, sh., for.

Station 5059. Off Ose Saki, Japan. Bott. temp. 45°. 197–297 fms. Gy. s.

Station 5067. Off Ose Saki, Japan. Bott. temp. 45°. 293 fms. Bk. s., brk. sh.

Station 5072. Off Omai Saki, Japan. Bott. temp. 44.1°. 148–284 fms. Gy. m.

Station 5087. In Sagami Bay, Japan. Bott. temp. 37.5°. 614 fms. Gn. m.

Station 5088. In Sagami Bay, Japan. Bott. temp. 41.8°. 369–405 fms. Gn. m.

Station 5091. In Uraga Strait, Japan. Bott. temp. 47.6°. 197 fms. Gn. m., crs. bk. s., p.

Station 5092. In Uraga Strait, Japan. Bott. temp. 56.3°. 70 fms. Crs. bk. s.

Station 5095. In Uraga Strait, Japan. Bott. temp. 57.8°. 58 fms. Fne. bk. s., brk. sh.

Bathymetrical range, 31–850 fms. Extremes of temperature, 57.8°–34.9°.

Four hundred and ninety-four specimens.

Brisaster moseleyi.

Schizaster moseleyi A. Agassiz, 1881. CHALLENGER Ech., p. 203.
Schizaster (Brisaster) moseleyi Mortensen, 1907. INGOLF Ech., pt. 2, p. 123.

Plates 155; fig. *5*; 156, fig. *4*.

This seems to be the southern representative of the preceding species but is easily distinguished by the broader, higher test and the longer, narrower petals. The CHALLENGER specimens were all from the southern coasts of Chile. I think the specimens recorded in the CHALLENGER Report from Kerguelen are the following species, while that from Station 146 at a depth of 1375 fms. needs further examination. The ALBATROSS made three dredgings off southern Chile in depths exceeding 1000 fms. and *moseleyi* did not occur in any one of them, while of the nine dredgings at less than 700 fms., this species occurred in seven.

Station 2780. Western entrance to Strait of Magellan. Bott. temp. 46.9°. 369 fms. Gn. m.

Station 2781. Off Queen Adelaide Island, Chile. Bott. temp. 49.9°. 348 fms. Bu. m.

Station 2782. Near Cambridge Island, Chile. Bott. temp. 47.9°. 258 fms. Bu. m.

Station 2784. Off Campana Island, Chile. Bott. temp. 51.9°. 194 fms. Bu. m.

Station 2785. Off Campana Island, Chile. Bott. temp. 46.9°. 449 fms. Bu. m.

Station 2787. Taytao Archipelago, Chile. Bott. temp. 53.9°. 61 fms. Gn. m.

Station 2791. Near Valdivia, Chile. Bott. temp. 37.9°. 677 fms. Yl. m.

Bathymetrical range, 61–677 fms. Extremes of temperature, 53.9°–37.9°.

Eighty-eight specimens.

Brisaster kerguelenensis, sp. nov.

Plate 154, figs. *15–17*.

Length 55 mm.; breadth, at middle, where widest, 47 mm.; height just back of abactinal system, where highest, 27 mm. Abactinal system 40 mm. back of anterior margin. Petal III deeply sunken, about 35 mm. long by

7.5 mm. wide. Petals II and IV not very divergent, slightly outwardly curved at tip, about 28 mm. long by 5 mm. wide, near tip. Petals I and V very small, about 7 mm. long by 3 mm. wide, with about a dozen pore-pairs on each side. Genital pores, 3, rather large, those in interambulacra 3 and 4 very close together. Peripetalous fasciole very distinct but lateroanal fasciole entirely wanting. Periproct about 10 mm. high by 7 mm. wide. Ambulacrum III very deeply sunken, and labium narrow and very projecting; as a result, the peristome is nearly vertical instead of horizontal as usual. Sternum (from tip of labium) nearly 40 mm. long and scarcely 14 mm. wide, closely covered with rather small tubercles; while not keeled the sternum is distinctly projecting.

Pedicellariae of two kinds were found, but of the globiferous only a single specimen. This had valves .65 mm. long, not distinguishable from those of *fragilis*. The tridentate pedicellariae, on the other hand, are exceedingly abundant and very variable in size and form. The valves range from .20 to .75 mm. in length and may be straight or curved. Many of those with curved valves might be called rostrate pedicellariae but there is so much intergradation that it is better to consider them all tridentate. None of the various forms appears to be significant.

The color of the dry specimen is brown with the minute spines of the peripetalous fasciole a much darker shade, almost black. It was taken by the CHALLENGER off London River, Kerguelen Island, in 110 fms. and bears the M. C. Z. Cat. No. 2953.

More abundant material is of course necessary before the differences between this species and *moseleyi* can be regarded as clearly fixed but there can be no doubt that the Kerguelen Brisaster is distinct from the Chilean species. The belief that *moseleyi* is a deep-water species whose range might naturally extend to Kerguelen seems a mistake. The CHALLENGER took Brisaster at Kerguelen only in 110 and 120 fms. while the GAZELLE did not meet with it at all.

Hypselaster,[1] gen. nov.

Type, *Schizaster* (*Periaster*) *limicola* A. Agassiz, 1878. Bull. M. C. Z., 5, p. 193.

The genus Periaster was proposed by D'Orbigny for certain Fossil spatangoids, with which it seems erroneous to unite the Recent species of which *limicola* is a type, and I have therefore selected the name Hypselaster for this latter group. The presence of only two genital pores, the incompleteness or lack of

[1] Ὑψηλός = high + ἀστήρ = star, in allusion to the great height of the test.

the lateroanal fasciole and the slightly sunken petals are all good characters separating the group from the true Periasters. It is possible that Gray's *Schizaster jukesii* should be included in Hypselaster but the deeply sunken petal III seems to prevent such a disposition of that little-known species, and I reluctantly place it among the at present unidentifiable forms. It probably belongs in Schizaster.

Key to the Species of Hypselaster.

Test very large, length 100 mm. or more; a bare band 2 mm. wide connects the upper end of periproct with the peripetalous fasciole . . . . . *maximus.*
Test much smaller; length usually under 60 mm.; no conspicuous bare band between peripetalous fasciole and periproct.
  Test nearly as high anteriorly as at posterior end.
    Petals II and IV only 1.5 times as long as I and V; petal III not twice as long as I and V . . . . . *limicolus.*
    Petals II and IV twice as long as I and V; petal III 2.5 times as long as I and V . . . . . *rotundus.*
  Test distinctly higher posteriorly than anteriorly.
    Apical system central or a little anterior . . . . . *fragilis.*
    Apical system distinctly posterior.
      Petals I and V nearly half as long as II and IV; peristome large (7 by 3 mm.) . . . . . *kempi.*
      Petals I and V much less than half as long as II and IV; peristome small (4 × 2 mm.) . . . . . *brachypetalus.*

Hypselaster maximus.

Periaster maximus A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 259.

Plate 154, fig. *18*.

This species is based on a large fragment, of a light brown color, consisting of the posterior left-hand quarter, approximately, of the abactinal part of the test, and including the most of petal I and all of petal V. The genital pores are not shown and it is only by inference that the species is placed in Hypselaster. A perfectly bare band, 2 mm. wide and nearly 50 mm. long, runs from the posterior part of the peripetalous fasciole, in the median line, to the periproct, which is present and measures 11 mm. across. Petal V is 18 mm. long and 6 mm. wide. The shape of this species was apparently much like that of *limicolus* and if, by comparison with a specimen of that species 65 mm. long, we calculate its dimensions, we find that the holotype of *maximus* must have been about 110 mm. long, 105 mm. wide and 95 mm. high. The spines

PLATE 144.

1–5. **Rhyncholampas pacifica** (A. Ag.).

1. Miliary spine. × 95.
2. Tridentate (or rostrate?) pedicellaria. × 30.
3. Valve of tridentate (rostrate?) pedicellaria. × 95.
4. Side view of blade of tridentate (rostrate?) pedicellaria. × 95.
5. Valve of small tridentate pedicellaria. × 95.

6, 7. **Rhyncholampas caribocarum** (Lamarck).

6. Valve of ophicephalous pedicellaria. × 95.
7. Blade of tridentate (rostrate?) pedicellaria, tipped forward to show long teeth. × 95.

8–11. **Oligopodia recens** (Milne Edw.).

8. Valve of tridentate pedicellaria. × 95.
9. Valve of ophicephalous pedicellaria. × 95.
10. Side view of base of valve of tridentate pedicellaria. × 95.
11. Valve of triphyllous pedicellaria. × 425.

12, 13. **Oligopodia epigonus** (von Mart.).

12. Valve of tridentate pedicellaria. × 425.
13. Valve of ophicephalous pedicellaria. × 425.

14–16. **Echinolampas alexandri** de Lor.

14. Valve of tridentate pedicellaria. × 95.
15. Valve of ophicephalous pedicellaria. × 95.
16. Valve of small tridentate pedicellaria. × 95.

17. **Echinolampas crassa** (Bell).

17. Valve of tridentate pedicellaria. × 95.

18, 19. **Echinolampas depressa** Gray.

18. Blade of valve of tridentate pedicellaria. × 95.
19. Valve of ophicephalous pedicellaria. × 95.

20–24. **Echinolampas sternopetala** A. Ag. & Cl.

20. Valve of triphyllous pedicellaria. × 425.
21. Valve of ophicephalous pedicellaria. × 95.
22. Valve of tridentate pedicellaria. × 95.
23. Outlines to show margin of blade of small tridentate pedicellariae. × 95.
24. Valve of very small tridentate pedicellaria. × 95.

25–32. **Conolampas sigsbei** (A. Ag.).

25. Sphaeridium. × 95.
26. Valve of ophicephalous pedicellaria. × 95.
27. Side view of base of valve of ophicephalous pedicellaria. × 95.
28. Blade of valve of triphyllous pedicellaria, seen from above. × 425.
29. Side view of valve of triphyllous pedicellaria. × 425.
30. Valve of tridentate pedicellaria. × 95.
31. Oblique view of blade of valve of tridentate pedicellaria. × 95.
32. Calcareous particles from abactinal tube-feet. × 425.

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PLATE 145.

1, 2. **Cystocrepis setigera** (A. Ag.).

1. Valve of tridentate pedicellaria. × 95.
2. Valve of triphyllous pedicellaria. × 95.

3–6. **Plexechinus cinctus** A. Ag.

3. Valve of ophicephalous pedicellaria. × 95.
4. Side view of valve of rostrate pedicellaria. × 95.
5. Valve of rostrate pedicellaria. × 95.
6. Valve of tridentate pedicellaria. × 95.

7–12. **Phryssocystis multispina** A. Ag. & Cl.

7. Head of ophicephalous pedicellaria. × 95.
8. Valve of ophicephalous pedicellaria. × 95.
9. Valve of triphyllous (small tridentate?) pedicellaria. × 95.
10. Top of stalk of ophicephalous pedicellaria. × 95.
11. Valve of stout tridentate pedicellaria. × 95.
12. Valve of slender tridentate pedicellaria. × 95.

13–19. **Palaeopneustes cristatus** A. Ag.

13. Side view of valve of rostrate pedicellaria. × 95.
14. Valve of rostrate pedicellaria. × 95.
15. Valve of big tridentate pedicellaria. × 40.
16. Valve of triphyllous pedicellaria. × 95.
17. Valve of ordinary tridentate pedicellaria. × 95.
18. Valve of slender tridentate pedicellaria. × 95.
19. Valve of ophicephalous pedicellaria. × 95.

20–26. **Archaeopneustes hystrix** (A. Ag.).

20. Calcareous spicule from tube-foot. × 95.
21. Valve of triphyllous pedicellaria. × 95.
22. Head of stout tridentate (rostrate?) pedicellaria. × 40.
23. Triphyllous pedicellaria. × 40.
24. Head of slender tridentate pedicellaria. × 40.
25. Tip of valve of slender tridentate pedicellaria. × 40.
26. Tip of valve of stout tridentate (rostrate?) pedicellaria. × 40.

27–34. **Palaeotropus josephinae** Lovén. (From West Indies).

27. Valve of ophicephalous pedicellaria. × 95.
28. Valve of triphyllous pedicellaria. × 95.
29. Valve of globiferous pedicellaria. × 95.
30. Side view of valve of globiferous pedicellaria. × 95.
31. Calcareous spicules from tube-feet. × 95.
32. Valve of rostrate pedicellaria. × 95.
33. Side view of valve of rostrate pedicellaria. × 95.
34. Valve of tridentate pedicellaria. × 95.

35–39. **Nacospatangus gracilis** A. Ag.

35. Valve of globiferous pedicellaria. × 95.
36. Side view of valve of globiferous pedicellaria. × 95.
37. Side view of tip of valve of globiferous pedicellaria. × 290.
38. Valve of triphyllous pedicellaria. × 95.
39. Valve of tridentate pedicellaria. × 95.

40–43. **Nacospatangus depressus** H. L. Clark.

40. Valve of tridentate pedicellaria. × 95.
41. Valve of globiferous pedicellaria. × 95.
42. Side view of valve of globiferous pedicellaria. × 95.
43. Side view of tip of valve of globiferous pedicellaria. × 290.

44–46. **Palaeotropus thomsoni** A. Ag.

44. Blade of valve of rostrate pedicellaria. × 95.
45. Stalk of rostrate pedicellaria. × 95.
46. Valve of tridentate pedicellaria. × 95.

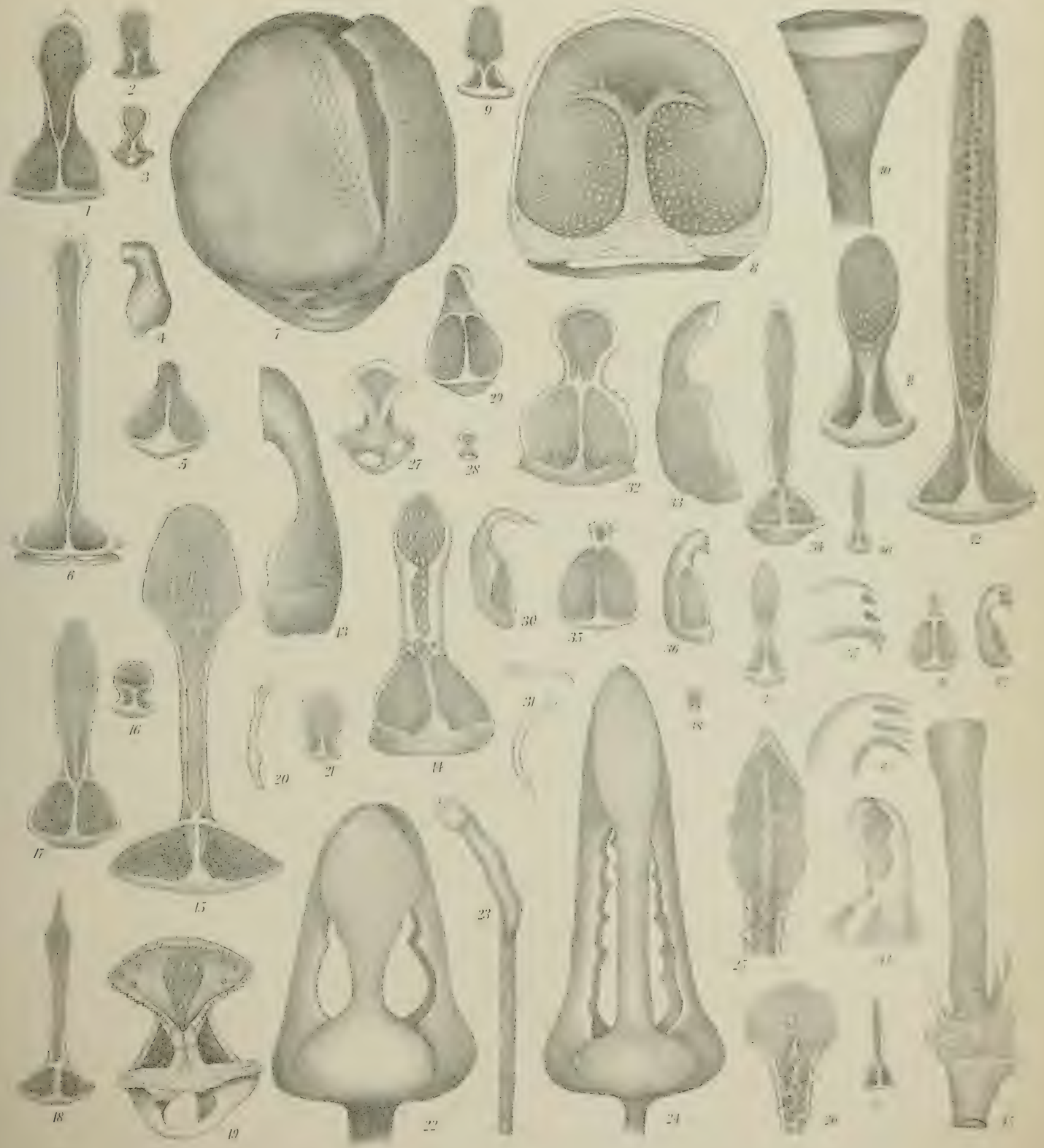

PLATE 146.

1–6. **Homolampas fulva** A. Ag.

1. Valve of rostrate pedicellaria. × 95.
2. Valve of slender tridentate pedicellaria. × 95.
3. Side view of valve of slender tridentate pedicellaria. × 95.
4. Rostrate pedicellaria. × 40.
5. Valve of stout tridentate pedicellaria. × 95.
6. Valve of triphyllous (?) pedicellaria. × 95.

7. **Homolampas hastata** A. Ag.

7. Outline of margin of base of valve of rostrate pedicellaria. × 95.

8. **Homolampas fragilis** (A. Ag.).

8. Outline of margin of base of valve of rostrate pedicellaria. × 95.

9, 10. **Hypselaster rotundus** (A. Ag. & Cl.).

9. Side view of valve of tridentate pedicellaria. × 95.
10. Side view of valve of rostrate pedicellaria. × 95.

11. **Hemiaster globulus** A. Ag. & Cl.

11. Valve of ophicephalous pedicellaria. × 95.

12. **Linopneustes longispinus** (A. Ag.).

12. Side view of valve of rostrate pedicellaria. × 40.

13. **Gymnopatagus magnus** A. Ag. & Cl.

13. Side view of valve of globiferous pedicellaria. × 95.

14. **Gymnopatagus micropetalus** H. L. Clark.

14. Side view of valve of rostrate pedicellaria. × 95.

15. **Brissus latecarinatus** (Leske).

15. Valve of slender tridentate pedicellaria. × 95.

16. **Metalia dicrana** H. L. Clark.

16. Valve of rostrate pedicellaria. × 95.

17. **Spatangus lütkeni** A. Ag.

17. Outline of blade of valve of stout tridentate pedicellaria. × 40.

18. **Spatangus pallidus** H. L. Clark.

18. Outline of blade of valve of stout tridentate pedicellaria. × 40.

19. **Spatangus paucituberculatus** A. Ag. & Cl.

19. Outline of blade of valve of stout tridentate pedicellaria. × 40.

20. **Spatangus californicus** H. L. Clark.

20. Outline of blade of valve of stout tridentate pedicellaria. × 40.

21, 22. **Plagiobrissus grandis** (Gmelin).

21. Valve of long globiferous pedicellaria. × 95.
22. Long globiferous pedicellaria. × 40.

23. **Moira clotho** (Mich.).

23. Stalk of globiferous pedicellaria. × 40.

24. **Pseudomaretia alta** (A. Ag.).

24. Globiferous pedicellaria. × 40.

25. **Maretia peloria** H. L. Clark.

25. Side view of valve of globiferous pedicellaria. × 40.

26, 27. **Rhynobrissus micrasteroides** A. Ag.

26. Valve of globiferous pedicellaria. × 95.
27. Side view of tip of valve of globiferous pedicellaria. × 95.

28, 29. **Rhynobrissus pyramidalis** A. Ag. (From Siam).

28. Valve of ophicephalous pedicellaria. × 95.
29. Side view of base of valve of ophicephalous pedicellaria. × 95.

30. **Metalia sternalis** (Lamarck).

30. Bidentate pedicellaria. × 95.

31. **Breynia australasiae** (Leach).

31. Valve of ophicephalous pedicellaria. × 95.

32, 33. **Pseudolovenia hirsuta** A. Ag. & Cl.

32. Head of multidentate pedicellaria. × 40.
33. Valve of multidentate pedicellaria. × 40.

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PLATE 147.

PLATE 147.

1, 2. **Echinolampus sternopetala** A. Ag. & Cl. × 3.

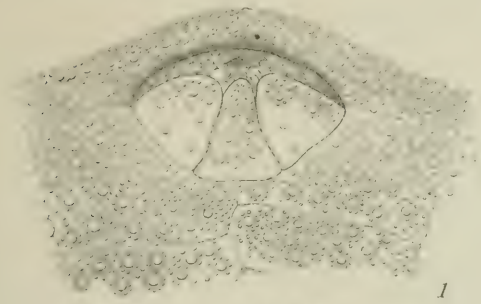
1. Periproctal region.
2. Apical system and petals.

3. **Urechinus loveni** (A. Ag.). × 3.

3. Apical system.

4–6. **Pycnolampas oviformis** A. Ag. & Cl. × 4.

4. Posterior view of holotype (St. 3838).
5. Abactinal view of same.
6. Actinal view of same.



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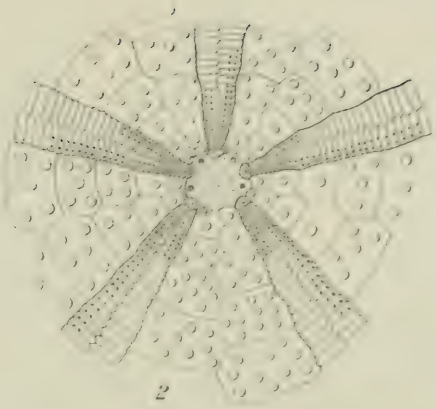

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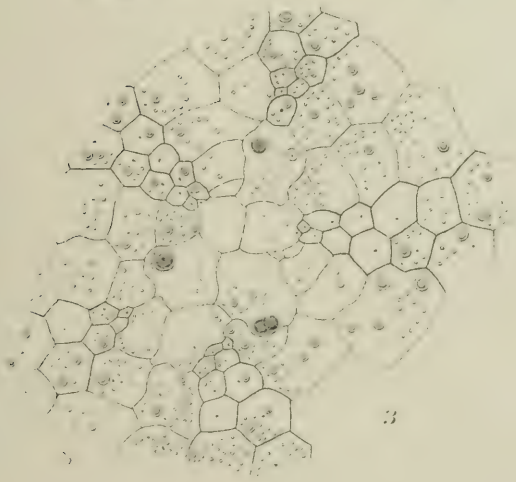

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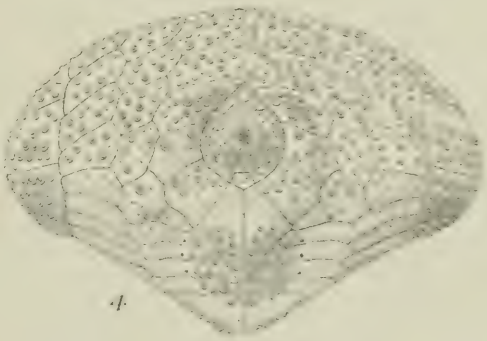

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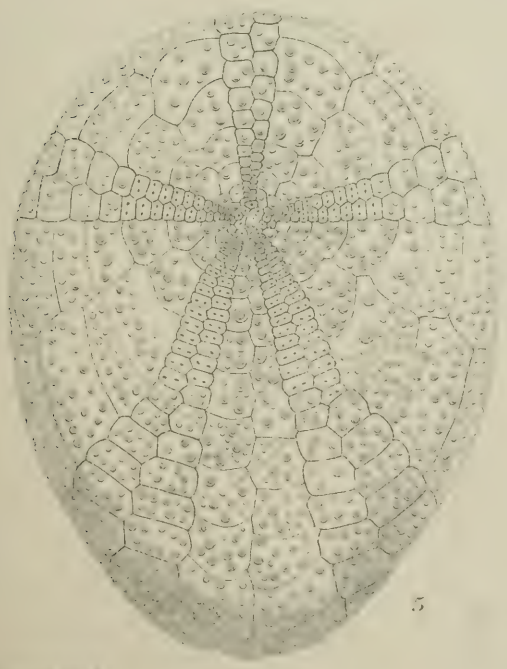

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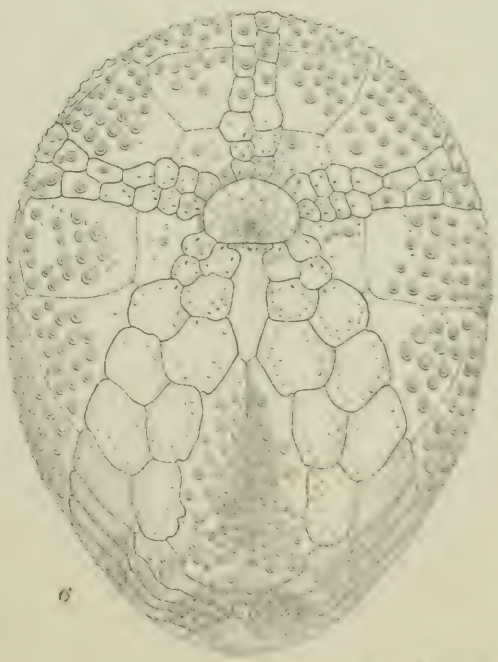

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PLATE 148.

PLATE 148.

1, 2. **Hypselaster rotundus** (A. Ag. & Cl.). × 2.

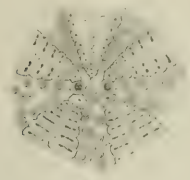
1. Apical system.
2. Peristomial region.

3, 4. **Hypselaster brachypetalus** H. L. Clark. × 4.

3. Apical system.
4. Peristomial region.

5–8. **Hypselaster fragilis** (A. Ag. & Cl.). × 4.

5. Posterior view of holotype (St. 4913).
6. Right-side view of same.
7. Abactinal view of same.
8. Actinal view of same.



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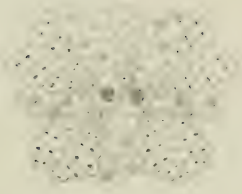

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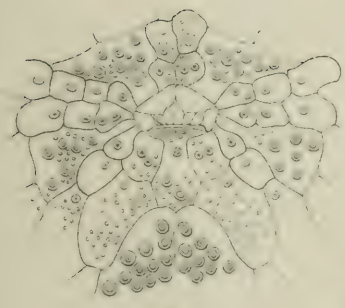

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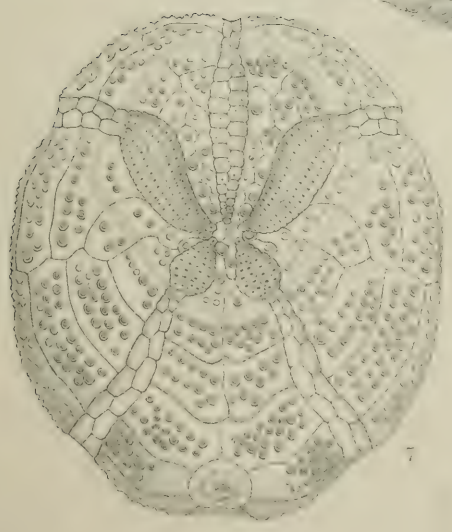

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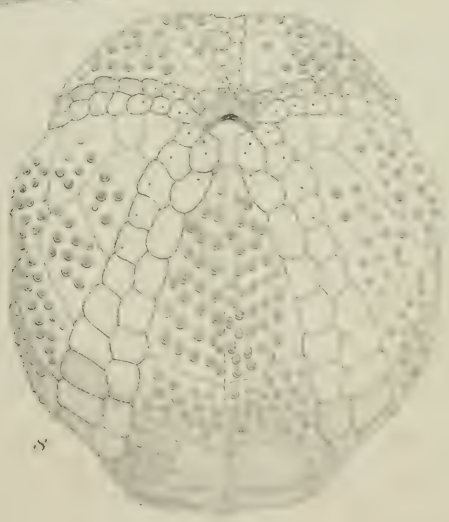

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Mem. Mus. Comp. Zool. Harvard

PLATE 149.

Plate 149.

1–3. **Gonimaretia laevis** H. L. Clark.

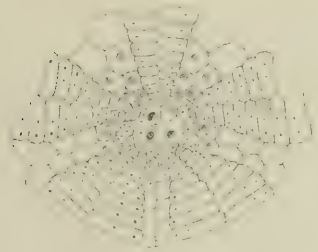
1. Apical system. × 5. (Interambulacral plate 5 *b* 1 should not separate the ocular plate from ambulacral plate I *a* 1).
2. Posterior view of bare test. × 4.
3. Peristomial region. × 4.

4. **Spatangus californicus** H. L. Clark.

4. Periproctal region and subanal plastron. × 2.

5. **Spatangus pallidus** H. L. Clark.

5. Posterior view of bare test. × 2.



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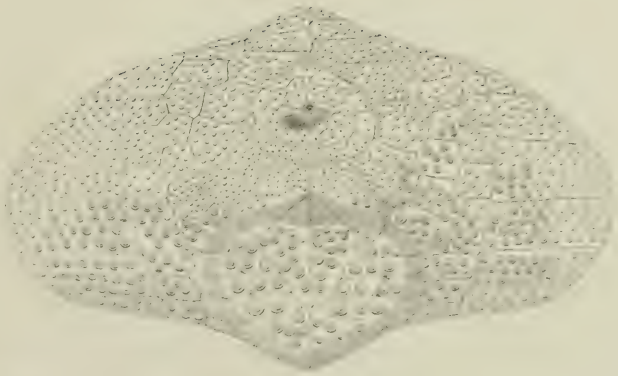

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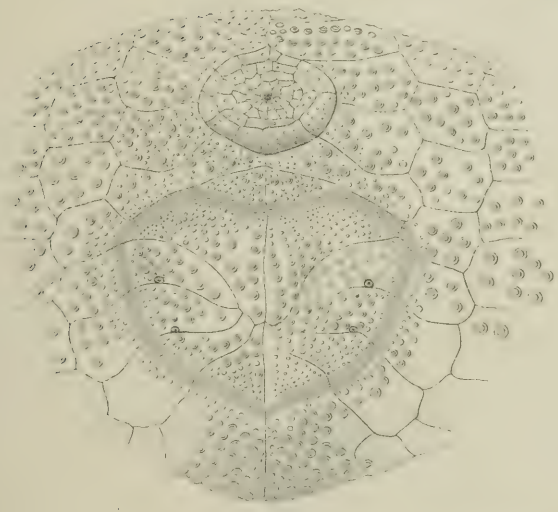

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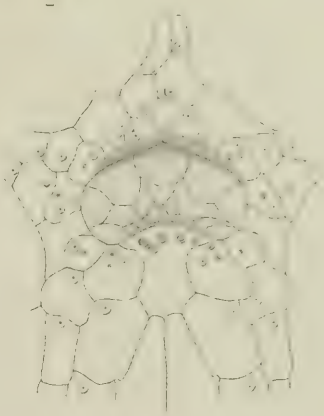

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PLATE 150.

PLATE 150.

1–3. **Echinocardium dubium** A. Ag. & Cl. × 4.

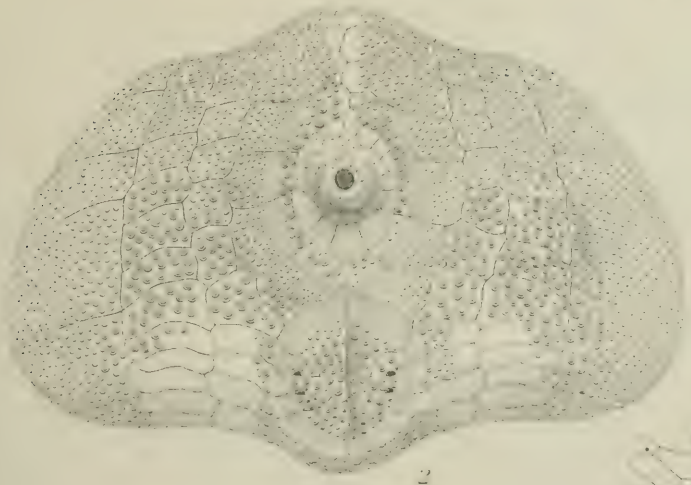
1. Abactinal view of holotype (St. 5047), partly restored and diagrammatic.
2. Posterior view of same.
3. Peristomial region.

4. **Hemiaster.**

4. Hypothetical apical system, to show passage from an ethmophract to an ethmolytic condition.

5. **Hemiaster globulus** A. Ag. & Cl.

5. Peristomial region. × 2.



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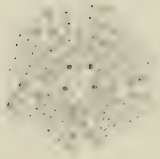

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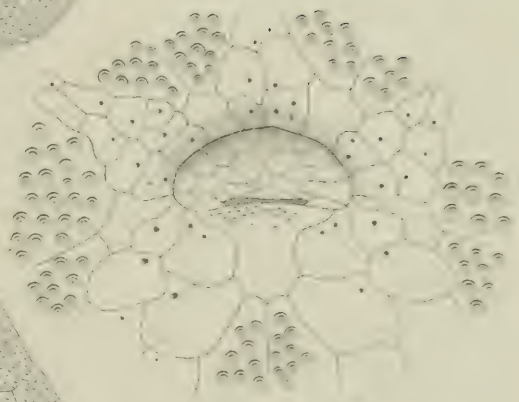

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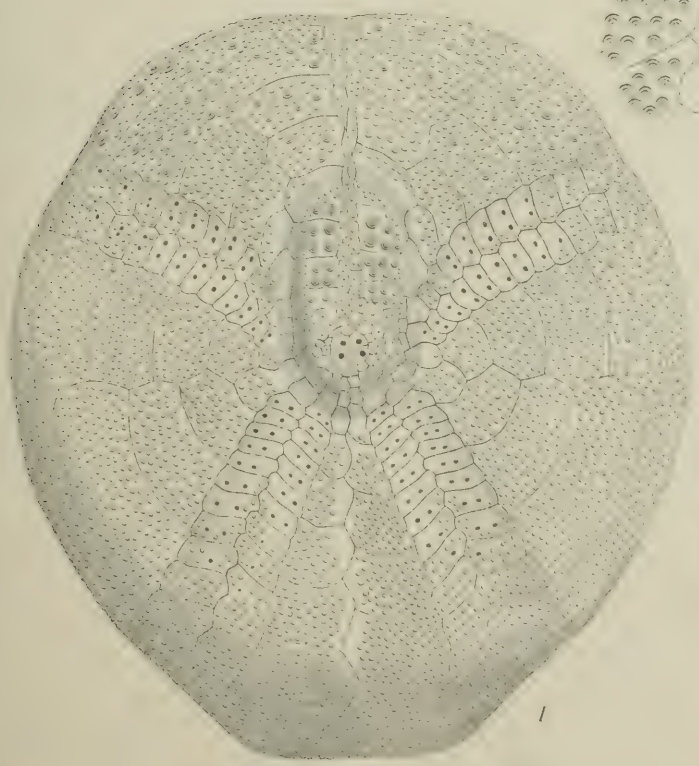

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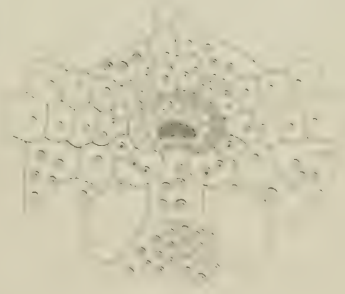

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Plate 151.

1–4. **Phryssocystis multispina** A. Ag. & Cl. Nat. size.

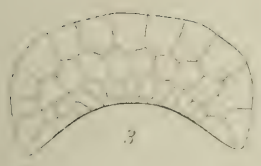
1. Fragment of actinal surface of test, to show primary spines.
2. Part of abactinal surface of test, to show spines and tuberculation.
3. Peristome.
4. Periproct.

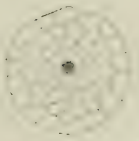
5. **Lovenia grisea** A. Ag. & Cl. Nat. size.

5. Abactinal view of holotype (St. 4080), partly restored.

6–8. **Argopatagus planus** (A. Ag. & Cl.). × 2.5.

6. Abactinal view of holotype (St. 4919).
7. Actinal view of same.
8. Right-side view of same.





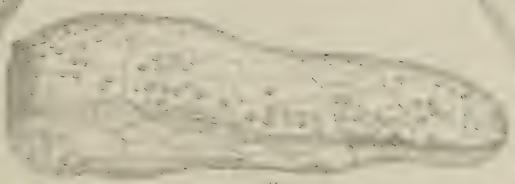


PLATE 152.

PLATE 152.

1–4. **Rhynobrissus placopetalus** A. Ag. & Cl. × 3.5.

1. Abactinal view of holotype (St. 4160).
2. Right-side view of same.
3. Actinal view of same.
4. Posterior view of same.

5–8. **Brissopsis luzonica** (Gray). × 3.

5. Abactinal view of young individual, holotype of *Brissopsis circosemita* A. Ag. & Cl. (St. 4070).
6. Right-side view of same.
7. Actinal view of same.
8. Posterior view of same.

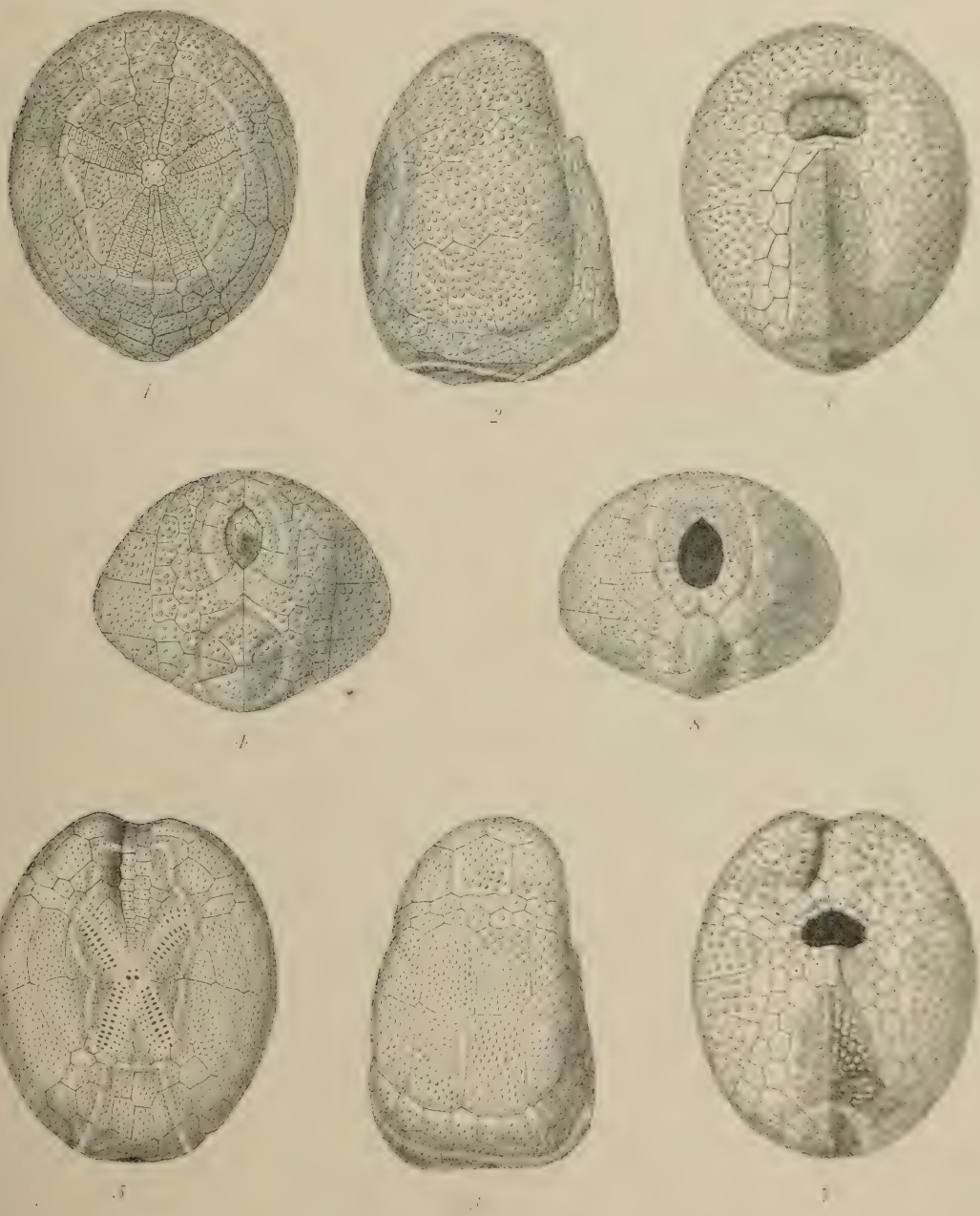


PLATE 153.

1, 2. **Echinolampas ovata** (Leske).

1. Right-side view of a specimen from Ceylon.
2. Abactinal view of same.

3, 4. **Echinolampas alexandri** de Lor.

3. Right-side view of a specimen from Ceylon.
4. Abactinal view of same.

5–7. **Echinolampas sternopetala** A. Ag. & Cl.

5. Abactinal view of holotype (St. 4934).
6. Right-side view of same.
7. Actinal view of same.

8. **Echinolampas depressa** Gray.

8. Abactinal view of a specimen from Grenada, B. W. I.

9, 10. **Echinolampas richardi** Desmoul.

9. Abactinal view of bare test from Cape Palmas, Liberia.
10. Right-side view of same.

All figures, natural size.

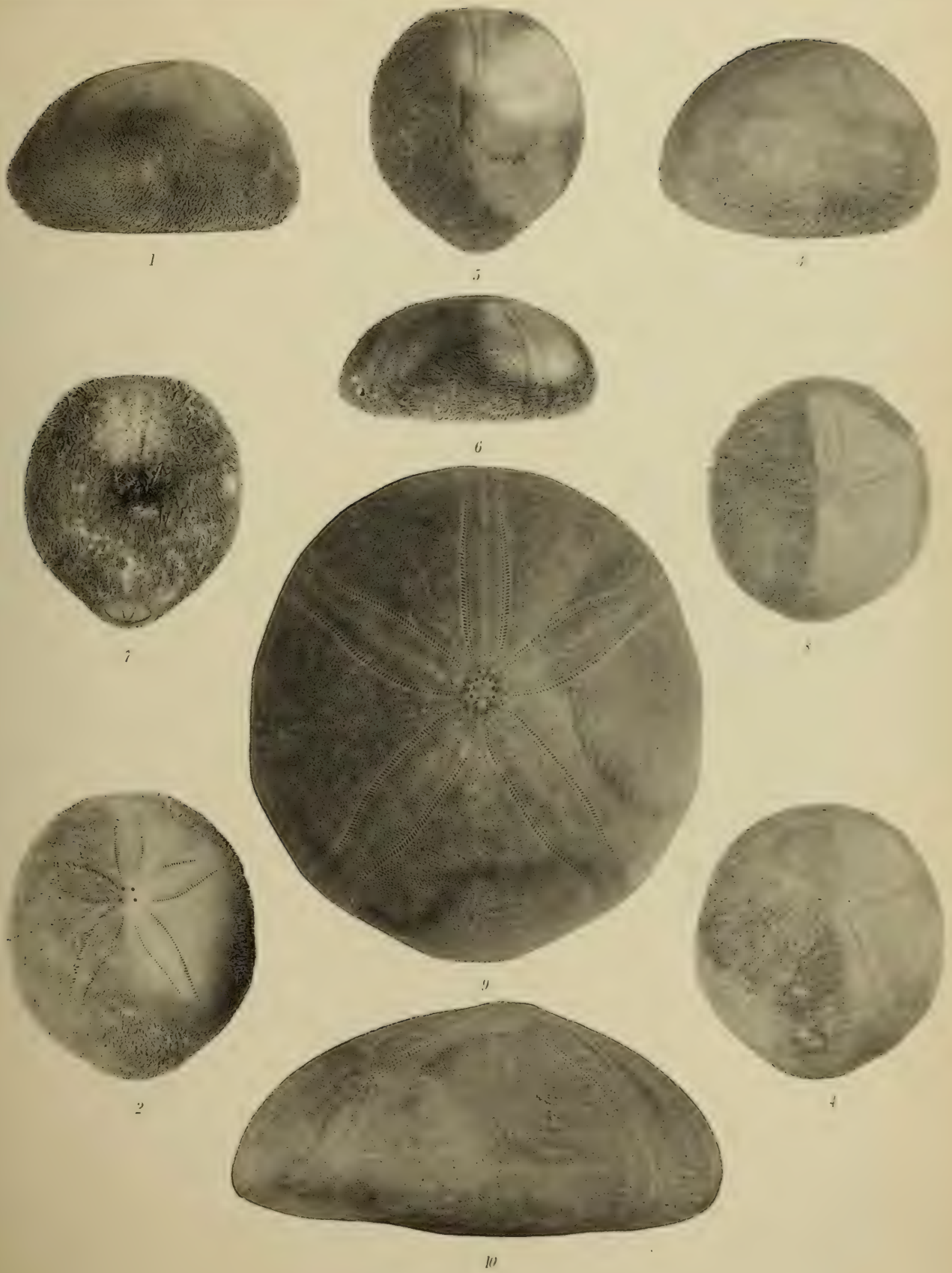

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PLATE 154.

PLATE 154.

1–3. **Hypselaster brachypetalus** H. L. Clark.

1. Abactinal view of holotype from near Grenada, B. W. I.
2. Actinal view of same.
3. Right-side view of same.

4–6. **Gymnopatagus micropetalus** H. L. Clark.

4. Abactinal view of holotype (St. 3749).
5. Actinal view of same.
6. Right-side view of same.

7–10. **Hemiaster globulus** A. Ag. & Cl.

7. Abactinal view of holotype (St. 4832).
8. Anterior view of same.
9. Actinal view of same.
10. Left-side view of same.

11–14. **Hypselaster rotundus** (A. Ag. & Cl.).

11. Abactinal view of holotype (St. 4946).
12. Left-side view of same.
13. Actinal view of same.
14. Anterior view of same.

15–17. **Brisaster kerguelenensis** H. L. Clark.

15. Left-side view of holotype from off London River, Kerguelen.
16. Abactinal view of same.
17. Actinal view of same.

18. **Hypselaster maximus** (A. Ag. & Cl.).

18. Abactinal view of holotype (St. 4130).

All figures, natural size.

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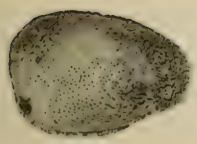

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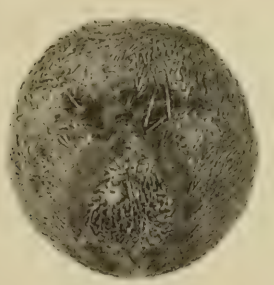

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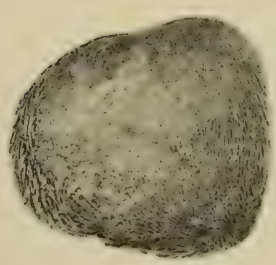

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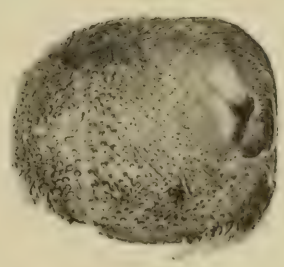

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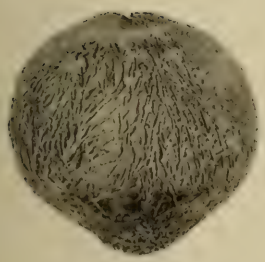

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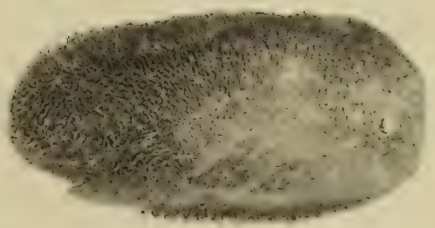

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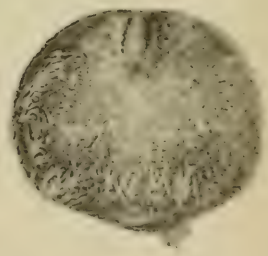

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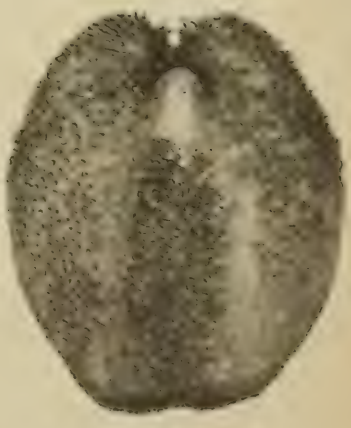

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PLATE 155.

Plate 155.

1. **Brissopsis pacifica** (A. Ag.).

1. Abactinal view of unusually large specimens (St. 3035).

2, 3. **Brissopsis luzonica** (Gray).

2. Abactinal view of specimen from the Hawaiian Islands.
3. Actinal view of same.

4, 6, 8. **Brisaster townsendi** (A. Ag.).

4. Abactinal view of bare test from off southern California (St. 2909).
6. Abactinal view of specimen from off southern California (St. 2892).
8. Actinal view of specimen shown in fig. 4.

5. **Brisaster moseleyi** (A. Ag.).

5. Abactinal view of bare test of a young individual from near Cambridge Island, Chile.

7, 9. **Tripylaster philippii** (Gray).

7. Abactinal view of bare test from the Straits of Magellan.
9. Actinal view of same.

All figures, natural size.

PLATE 156.

PLATE 156.

1–3. **Spatangus californicus** H. L. Clark.

1. Abactinal view of specimen from off southern California (St. 2972).
2. Actinal view of holotype (St. 2973).
3. Abactinal view of holotype.

4. **Brisaster moseleyi** (A. Ag.).

4. Abactinal view of a large, bare test from near Valdivia, Chile.

5–7. **Moira clotho** (Mich.).

5. Abactinal view of specimen from Panama.
6. Actinal view of same.
7. Left-side view of same.

All figures, natural size.

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PLATE 157.

PLATE 157.

1–4. **Spatangus pallidus** H. L. Clark.

1. Abactinal view of holotype from Sagami Bay, Japan.
2. Left-side view of same.
3. Actinal view of same.
4. Posterior view of same.

5, 6. **Spatangus lütkeni** A. Ag.

5. Left-side view of small specimen from Japan.
6. Posterior view of same.

7–9. **Spatangus paucituberculatus** A. Ag. & Cl.

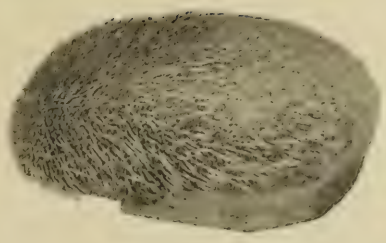
7. Right-side view of holotype (St. 3865).
8. Abactinal view of same.
9. Actinal view of same.

10. **Spatangus californicus** H. L. Clark.

10. Left-side view of holotype (St. 2973).

All figures, natural size.

1



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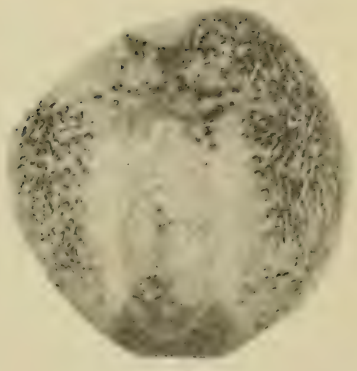

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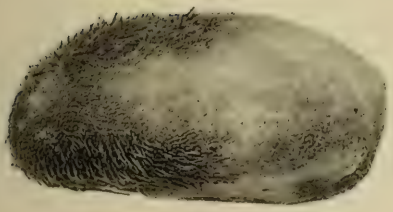

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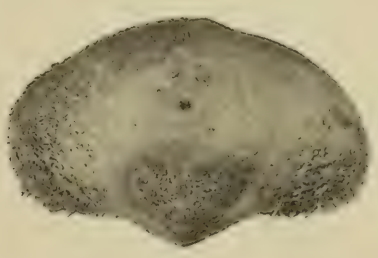

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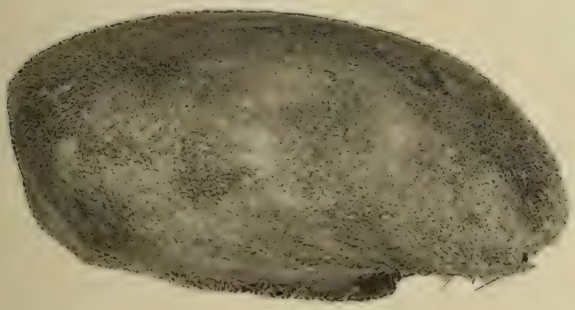

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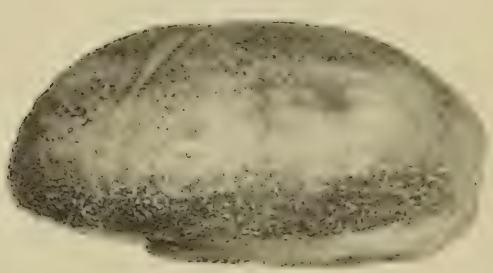

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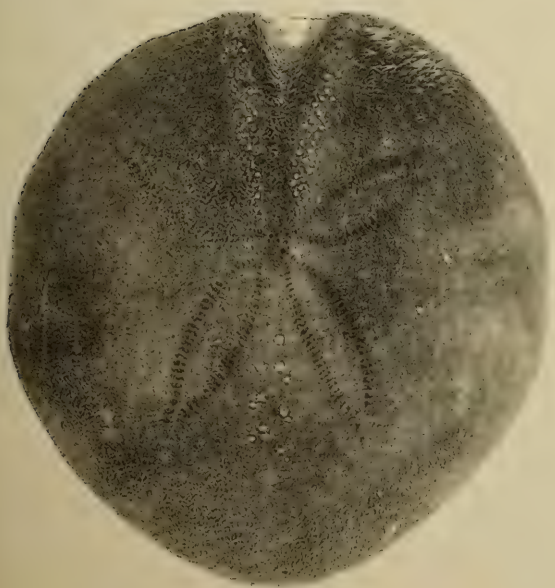

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PLATE 158.

PLATE 158.

1–4. **Gymnopatagus obscurus** A. Ag. & Cl.

1. Abactinal view of holotype (St. 4081).
2. Actinal view of same.
3. Right-side view of same.
4. Abactinal view of nearly bare test (St. 4081).

5. **Gymnopatagus micropetalus** H. L. Clark.

5. Abactinal view of the larger specimen (St. 3751).

6, 7. **Palaeotropus thomsoni** A. Ag.

6. Abactinal view of holotype from off South Carolina.
7. Left-side view of same.

All figures, natural size.

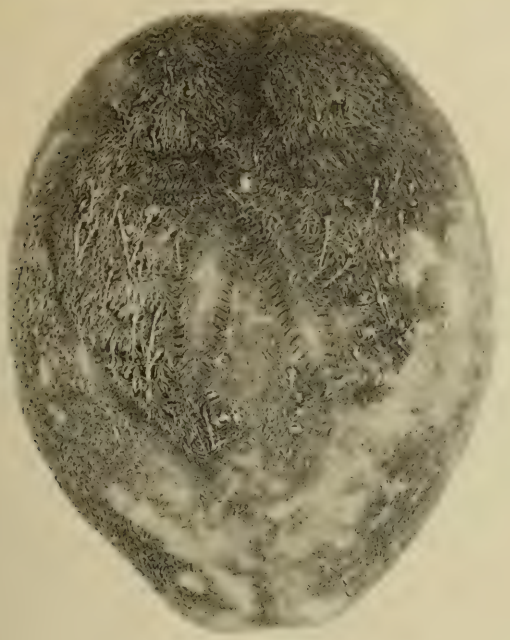

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PLATE 159.

PLATE 159.

1. **Gymnopatagus magnus** A. Ag. & Cl.

1. Abactinal view of holotype (St. 5082).

2–6. **Gymnopatagus pulchellus** A. Ag. & Cl.

2. Abactinal view of holotype (St. 3810).
3. Right-side view of same.
4. Actinal view of same.
5. Abactinal view of a young individual (St. 3810).
6. Actinal view of same.

All figures, natural size.

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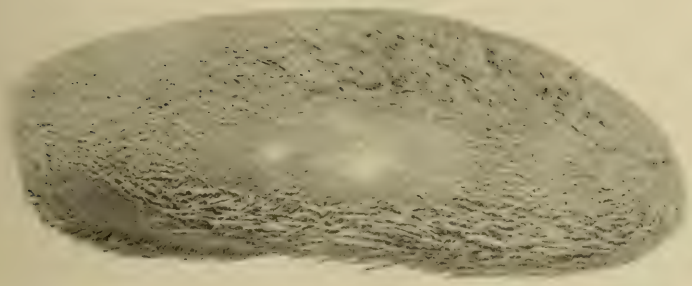

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PLATE 160.

PLATE 160.

1–4. **Metalia dicrana** H. L. Clark.

1. Abactinal view of bare test from Viti Levu, Fiji.
2. Posterior view of same.
3. Actinal view of same.
4. Right-side view of same.

5–7. **Maretia tuberculata** A. Ag. & Cl.

5. Abactinal view of holotype (St. 4875).
6. Right-side view of same.
7. Actinal view of same.

8–12. **Pseudolovenia hirsuta** A. Ag. & Cl.

8. Left-side view of holotype (St. 4083).
9. Actinal view of a smaller specimen (St. 3839).
10. Abactinal view of holotype.
11. Abactinal view of a larger specimen (St. 4122), to show the primary spines.
12. Actinal view of holotype.

All figures, natural size.

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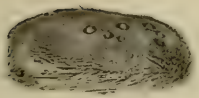

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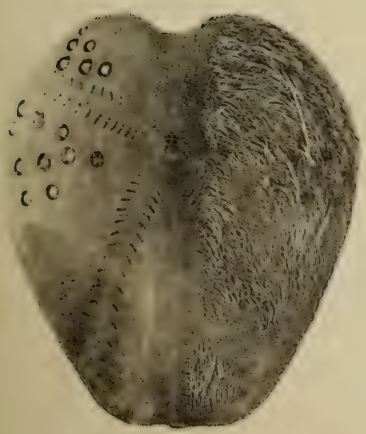

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PLATE 161.

PLATE 161.

1–4. **Lovenia camarota** H. L. Clark.

1. Abactinal view of holotype, from west of Torres Strait.
2. Right-side view of same.
3. Actinal view of same.
4. Posterior view of same.

5–7. **Gonimaretia laevis** H. L. Clark.

5. Actinal view of holotype (St. 2911).
6. Abactinal view of larger specimen (St. 2911).
7. Right-side view of holotype.

8–12. **Lovenia cordiformis** A. Ag.

8. Abactinal view of specimen from near Revillagigedo Islands.
9. Abactinal view of adult specimen from Gulf of Panama.
10. Right-side view of bare test of young individual from Lower California.
11. Abactinal view of same.
12. Actinal view of same.

All figures, natural size.

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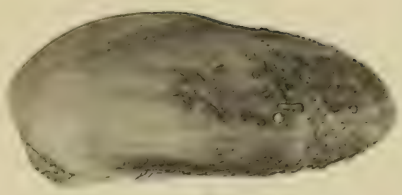

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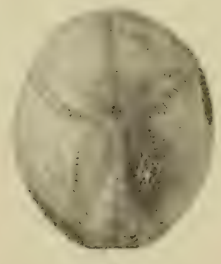

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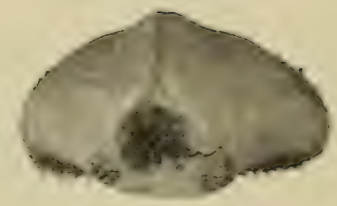

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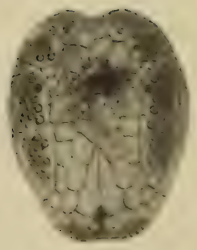

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are 4–5 mm. long, but within the fasciole there are a number of primary tubercles which must have carried much larger spines.

The pedicellariae are rather few. A single triphyllous was found, with rather narrow leaf-shaped valves about .10 mm. long. There were no globiferous pedicellariae seen but a number of tridentate occur. These are remarkable for their very slender valves, which measure fully 1.25 mm. in length, but have the base only .30 mm. wide and the slightly expanded tip only .10 mm. The valves are in shape very much like those of *Spatangus purpureus* as figured by Mortensen (1907, INGOLF Ech., pt. 2, pl. 16, figs. 1 and 9).

Station 4130. Off Hanamaulu, Kauai, Hawaiian Islands. Bott. temp. 46.1°. 283–309 fms. Fne. gy. s.

Hypselaster limicolus.

Schizaster (*Periaster*) *limicola* A. Agassiz, 1878. Bull. M. C. Z., 5, p. 193.

This interesting spatangoid was taken in the Gulf of Mexico by the BLAKE in 118 fms. It is also known from the ALBATROSS collections in the Gulf of Mexico at a slightly greater depth (142 fms.). The record in the CHALLENGER Report of its occurrence in the Arafura Sea has been shown by Mr. Agassiz to be a mistake and Mortensen has further shown that the specimens from the Arafura Sea do not belong to the present genus. On the other hand *Brissopsis alta* Mortensen occurs abundantly at the BLAKE station in the Gulf of Mexico where *limicolus* was first taken and as the form of the test is very similar, specimens of the Brissopsis have been identified and distributed as "Periaster limicola" and this has naturally led to confusion. The absence of a subanal fasciole and the presence of only 2 genital pores are sufficiently evident characters by which to distinguish Hypselaster easily. The pedicellariae of this species have been fully described by Mortensen.

Hypselaster rotundus.

Periaster rotundus A. Agassiz and Clark, 1907. Bull. M. C. Z., 51, p. 138.

Plates 146, figs. *9*, *10*; 148, figs. *1*, *2*; 154, figs. *11–14*.

Length 37 mm.; width, anterior to apical system, 35 mm.; height posteriorly 31 mm. The general form of the test may be better understood from the figures (Pl. 154, figs. *11–14*) than from any description. The peripetalous

fasciole is very distinct and is widest at the ends of the petals. Petal III is about 14 mm. long and 4–5 mm. wide, and is rather markedly depressed. The interambulacra between it and the adjoining petals are so compressed as to be distinctly carinate. Petals II and IV are very little sunken, widely diverging and distinctly curved, and measure 11 mm. long by 3.5 mm. wide. They have about twenty-one pore-pairs on each side. Petals I and V are 5.5 mm. long by less than 3 mm. wide, moderately diverging and little depressed. They have about twelve pore-pairs on each side. There are two large genital pores; their relative position and the arrangement of the plates of the abactinal system will be easily understood from the figure (Pl. 148, fig. *1*). The periproct is situated high upon the posterior, truncate end of the test; it is 5 mm. high, but scarcely 3 mm. wide. Some 12 mm. below it is a narrow fragment of an anal fasciole, irregularly V-shaped and not more than 10 mm. long altogether. At each of the lower posterior corners of the test are four somewhat enlarged tube-feet but they are not conspicuous. Below the periproct is an area about 10 mm. high and 3 mm. wide at the top which is bare of primary and secondary tubercles; near the lower end it becomes pointed by the encroachment of secondary tubercles. The sternum is about 16 mm. long by 15 mm. wide posteriorly; it is thickly covered with primary tubercles. The labrum is about 4 mm. long and carries only three primary tubercles. The peristome (Pl. 148, fig. *2*) is pentagonal, much wider than long, and covered by but few plates; it is not at all sunken and even the labrum projects little. The color of the test in the dry specimen is very pale brown; the spines are nearly or quite white.

The primary spines are slender and very fragile. On the upper surface and sides of the test they are only about 2 mm. long, but along the petals they become 3 or 4 mm. long and anteriorly, near the oral surface they are 5 mm. On the sternum they are 4 or 5 mm. long and conspicuously spatulate at tip. Pedicellariae are numerous and of two different kinds. The globiferous are fairly common and are like those of *Hemiaster expergitus* as figured by Mortensen (1907. Ingolf Ech., pt. 2, pl. 15, fig. 24), but the valves have a relatively higher and narrower base; they are .45–.60 mm. long and the base is about .30 mm. high and equally wide. The rostrate are abundant and remarkable for the greatly curved valves; these (Pl. 146, fig. *10*) are .25–.65 mm. long measured on the chord but .30–.85 measured on the arc. The tridentate are equally remarkable, but are very rare; the valves (Pl. 146, fig. *9*) are about .70 mm. long and have conspicuous sharp teeth on the back, as well as on the margins. Ophicephalous and triphyllous pedicellariae are very infrequent or at least hard

to find. The former have valves about .20 mm. long, with the loop .04–.08 mm. more, while in the latter, the valves are only about .10–.12 mm.

This interesting and well-characterized species is evidently closely related to *limicolus* but aside from the differences in the pedicellariae, which are very marked, the differences in the relative size of the petals and in the number of pore-pairs therein are important features. In *rotundus* petals I and V are just one half as long as II and IV, while in *limicolus* I and V are nearly two thirds as long as II and IV. In *rotundus* petals I and V have fewer than .65 as many pore-pairs as petals II and IV while in *limicolus* the posterior petals have three fourths as many pore-pairs as the anterior. The shape of the test readily distinguishes *rotundus* from any of the following species.

Station 4946. Between Kagoshima and Kobe, Japan. Bott. temp. 68.7°. 39 fms. Br. s., brk. sh., p.

One specimen.

Hypselaster fragilis.

Periaster fragilis A. Agassiz and Clark, 1907. Bull. M. C. Z., **51**, p. 138.

Plate 148, figs. *5–8*.

Length 16 mm.; width, where widest, back of abactinal system, 14 mm.; height, back of abactinal system, 10.5 mm. Test highest just back of middle, whence it slopes posteriorly and much more markedly anteriorly. The abactinal system is anterior to the middle of test, the general form of which, with the arrangement of its component plates will be most easily understood from the figures (Pl. 148, figs. *5–8*). The anterior petals, especially III, are slightly sunken and the interambulacra 2 and 4 are compressed near the abactinal system to form low, rounded ridges. Petals I and V are only about 2 mm. long and have only seven or eight pore-pairs on each side, while petals II and IV are over 5 mm. long and have 18–20 pore-pairs on each side. The periproct is well up on the posterior end of the test and is visible from above; it is relatively small, scarcely 2 mm. across. There are no genital pores and the outlines of the genital plates cannot be clearly determined. Interambulacra 1 and 4 appear to be shut out from the peristome (Pl. 148, fig. *8*) while dorsally they seem to terminate each in a single plate (Pl. 148, fig. *7*). Probably, however, better material will show the usual pair of plates here. The peripetalous fasciole is well marked and of nearly uniform width. About 3 mm. below the peri-

proct there is a faint indication of an anal fasciole. The sternum is about 9 mm. long and about 6 mm. broad posteriorly; it is fairly well covered with primary tubercles. The labrum and peristome (Pl. 148, fig. *8*) are very small; the former carries no tubercles and the latter is covered by numerous small plates. The primary tubercles and spines are rather sparsely scattered over the test, but miliary tubercles (not shown in the figures) are fairly abundant except actinally on the ambulacra. The test and primary spines are whitish, but the peripetalous fasciole is distinctly purplish.

Only one pedicellaria was found. That was a tridentate, with a short stalk only about one third as long as the head. The valves, which were about .25 mm. long, were slender, not compressed, and were rounded at the tip.

The specimen upon which this species is based is obviously immature and in the absence of genital pores, it is certainly hazardous to put it in this genus. But the general facies is so much like *Hypselaster brachypetalus* that there is little doubt of its generic position.

Station 4913. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

One specimen.

Hypselaster kempi.

Periaster kempi Koehler, 1914. Ech. Indian Mus. Spat., p. 162.

This is a well-defined species of good size characterized by the shape of the test, the position of the apical system, the relative proportions of the petals, and the form of the globiferous pedicellariae. Koehler considers it nearly allied to *limicolus*, but this does not seem so. Koehler, however, appears to have neglected the important point made by both Mr. Agassiz and Dr. Mortensen that the "*limicola*" recorded in the CHALLENGER Report from the Arafura Sea is not *limicola* and is not even congeneric with it. When therefore Koehler compares the globiferous pedicellariae of *kempi* with those of the "*limicola*" from the Arafura Sea, he is not making any comparison with the true *limicola!* As a matter of fact the globiferous pedicellariae of *kempi* raise the question at once whether the species should be placed in Hypselaster, but I hesitate to reject it on that account alone. The INVESTIGATOR took *kempi* in the Laccadive Sea in 1150–1170 fms. and in the eastern part of the Bay of Bengal in 1192 fms.

Hypselaster brachypetalus,[1] sp. nov.

Plates 148, figs. *3*, *4*; 154, figs. *1–3*.

Length, 25 mm.; width of test, where widest, near middle, 21 mm.; height of test where highest, near posterior end, 17.5 mm. The form of the test will be most clearly understood from the figures (Pl. 154, figs. *1–3*). The abactinal part of interambulacrum 5 forms a distinct, though rounded, keel. Peripetalous fasciole distinct but narrow and of nearly uniform width; it encloses an area only 14 mm. long and 12 mm. wide. There is no trace of an anal fasciole unless a single, very regular series of minute miliary tubercles is to be so interpreted; this series is about 3 mm. long and lies 4 mm. below the periproct. The petals are very little sunken. Petal III is about 9 mm. long and scarcely 1.5 mm. wide, while petals II and IV are 6.5 long by 2 wide. These latter petals have about thirteen pore-pairs on each side, but in petals I and V, which are only 2 mm. long there are barely half a dozen pore-pairs on each side (Pl. 148, fig. *3*). Genital pores 2, large, completely obscuring the sutures between genitals 1 and 2 on the one hand, and 3 and 4 on the other. Periproct near upper margin of posterior end, oval, narrower above, about 3 mm. high by 2.5 mm. wide, covered by relatively few plates, the two largest occupying the whole of the upper, narrow end. There are no conspicuous tube-feet at posterior end of test. Sternum somewhat projecting, about 12 mm. long by 6 mm. wide posteriorly. Labrum (Pl. 148, fig. *4*) short, markedly T-shaped, not as long as the first ambulacral plates. Peristome much wider than long covered by many small, thin plates; it is scarcely sunken at all and the labium projects but little. Color of test and spines, in the dry specimen, nearly white, with the peripetalous fasciole light brown; the dried spine-muscles give a brown cast to the anterior end of test and the sternum. Primary spines broken or wanting.

Of pedicellariae, I have found only a couple of tridentate but these proved of no little interest because they so closely resemble those of *H. kempi* as figured by Koehler (1914. Ech. Indian Mus. Spat., pl. 19, figs. 8–10). The valves are straight, about .33 mm. long, very little compressed and with nearly parallel sides, which are conspicuously serrate. The blade is widest near tip, but it is very little narrower at its base.

There can be no doubt that this species is nearly allied to the preceding and I greatly regret that no globiferous pedicellariae were found on the specimen,

[1] Βραχύς = short + πέταλον = a petal, in allusion to the very short posterior petals.

from which most of the spines seem to have been rubbed off when it was collected. The posterior petals are so much shorter than in *kempi*, the peristome is so much smaller relatively and the labrum is so much shorter that I am justified in not identifying the present specimen with that species.

The holotype of *brachypetalus* in unique. It was taken by the BLAKE at Station 268, near Grenada, in 955 fms., and bears the label in Mr. Agassiz's handwriting: "Schizaster cf. *S. limicola*."

Ova.

Gray, 1825. Ann. Phil., **26**, p. 431.
Type, *Spatangus canaliferus* Lamarck, 1816. Anim. s. vert., **3**, p. 31.

I see no escape from the necessity of using Gray's name for the spatangoid Lamarck called *Spatangus canaliferus*. In order to preserve the long familiar name Schizaster for the forms with which it is naturally associated, it is necessary therefore to separate *canaliferus* from the others and I have done this on the strength of the difference in the arrangement of the pores in petal III. Under other conditions I should not consider this a valid generic character but in order to save Schizaster, I recognize it as such. The genus is monotypic with the well-known Mediterranean species as its only member.

Schizaster.

Agassiz, 1836. Prod. Mon. Rad., p. 18 (185).
Type, *Schizaster studeri* Agassiz, 1836, *loc. cit.*

Agassiz included in his proposed genus only two species, *atropos* of Lamarck and *studeri* Agassiz. The former was removed by Michelin in 1855 to form the genus Moera, leaving *studeri* as type of Schizaster. In spite of there being no description of *studeri* published at this time, it was not a *nomen nudum*. Agassiz designated it as from the Italian Tertiary, following a satisfactory generic diagnosis and the statement that there was one fossil species. Sismonda (1843. Mem. Ech. Foss. Nizza, p. 32) gives a good description and figure and refers the species to Agassiz, showing that he did not think of the name as a *nomen nudum*. It is unfortunate that the genus must take for its type a Fossil species but there seems to be no legitimate way by which one of the Recent species can serve in that capacity.

As a matter of fact the Recent species of the genus are very unsatisfactorily known. Even if we follow Lovén, and Mortensen, in identifying Mr. Agassiz's

S. japonicus with Linné's *lacunosus*, which I confess it is hard to do, the nominal species *orbignyanus* and *edwardsi* are so imperfectly known that it is difficult to make a rational separation of the three forms. Mortensen thinks two species are confused under the name *orbignyanus* but while that is possible, I do not feel at all sure of it. The material accessible throws no light on these various problems. I may add that Gray's *Schizaster jukesii* is probably a true Schizaster.

Key to the Species of Schizaster.

Width of petal III one fourth of test-width or less; posterior petals little divergent, distance between tips only about .30 of petal-length.
  Sternum narrow, its posterior width only about one half its length . . . . . *orbignyanus.*
  Sternum broad, its posterior width about two thirds of its length . . . . . *lacunosus.*
Width of petal III about one third of test-width; posterior petals strongly divergent, distance between tips more than .50 of petal-length . . . . . *edwardsi.*

Schizaster orbignyanus.

A. Agassiz, 1880. Bull. M. C. Z., **8**, p. 84.

It is a puzzling fact that although Mr. Agassiz in his first report on the BLAKE Echini (*loc. cit.*) lists 11 stations where this species was taken, there are only three specimens in the M. C. Z. and only two of these are BLAKE specimens. One of these is a bare test, the HOLOTYPE of the species (M. C. Z. Cat. No. 2956), from off Barbados in 209 fms.; it is figured in the final BLAKE Report, pl. 28, figs. 1–4. The second is a young specimen from near Grenada in 170 fms. Our third specimen is a small crushed bare test found under a fragment of coral-rock, along shore, at Montego Bay, Jamaica. I can only account for the absence of material in our collection on the assumption that after the publication of the BLAKE Report, Mr. Agassiz found that some other spatangoid had been confused with *orbignyanus* in making out the list of stations where the latter was taken. Mortensen (1907. INGOLF Ech., pt. 2, p. 117–119) has given a good summary of the difficulties to be faced in attempting to recognize *orbignyanus* and *edwardsi*.

Schizaster lacunosus.

Echinus lacunosus Linné, 1758. Syst. Nat., ed. 10, p. 665.
Schizaster lacunosus Lovén, 1887. Ech. Linn., p. 168.

While not convinced that Lovén is correct in his interpretation of Linné's *E. lacunosus*, I cannot see that anything but confusion can result from disputing

it. Since Mortensen has accepted it and has further identified with Linné's species, Gray's *ventricosus*, and A. Agassiz's *japonicus*, the simplest and best action is to concur in this decision and thus attach Linné's name to a form of which enough material is available from known localities to give a satisfactory knowledge of the species. As it has been described and discussed by Lovén, A. Agassiz, Döderlein, and Mortensen, there is nothing of importance to add here. The ALBATROSS series is made up of specimens 15–60 mm. in length, all from Japan. The smallest and a specimen 18 mm. long have no genital pores, but they are evident enough in specimens 30 mm. in length. The largest specimen is 54 mm. broad and 44 mm. high; its breadth is thus .90 of the length and the height is .73. Another specimen not quite so large has the breadth .86 of length and the height about .78.

In the report on the ALBATROSS Hawaiian collection (1907. Bull. M. C. Z., 50, p. 259) a very young specimen of *Schizaster japonicus* is recorded from near Kauhola Light, Hawaii. Further study of this specimen, in comparison with the smallest available specimens of *lacunosus* make me doubt whether the specimen is a true Schizaster at all. There is no indication of a lateroanal fasciole and I am inclined to think this young individual is probably an immature Brisaster. At any rate it is quite erroneous to consider *S. lacunosus* a member of the Hawaiian fauna on the basis of this specimen.

Station 3723. Off Yokkaichi Light, Honshu Island, Japan. Bott. temp.? 13–16 fms. M., s., p., sh.

Station 4939. Kagoshima Gulf, Japan. Bott. temp.? 85 fms. Bott.?

Station 4940. Kagoshima Gulf, Japan. Bott. temp. 59.8°. 115 fms. Br. m., bk. sp.

Station 4942. Kagoshima Gulf, Japan. Bott. temp.? 118 fms. Bott.?

Station 4943. Kagoshima Gulf, Japan. Bott. temp.? 119 fms. Bott.?

Station 4945. Kagoshima Gulf, Japan. Bott. temp. 60.4°. 70 fms. Gn. m.

Station 4961. Between Kobe and Yokohama, Japan. Bott. temp. 70.1°. 33 fms. Fne. gy. s., m.

Station 4962. Between Kobe and Yokohama, Japan. Bott. temp.? 36 fms. Bott.?

Station 4964. Between Kobe and Yokohama, Japan. Bott. temp. 66.6°. 37 fms. Fne. gy. s., m.

Bathymetrical range, 13–119 fms. Extremes of temperature, 70.1°–59.8°.

Forty specimens.

Schizaster edwardsi.

Cotteau, 1889. Bull. Soc. Zool. France, **14**, p. 341.

Although Cotteau subsequently gave good figures and a detailed description of his specimens, there are some important matters on which more light is needed before this species can be considered satisfactorily known. The type specimens were from the vicinity of Cape Palmas, Liberia, in shallow water.

Moiropsis.

A. Agassiz, 1881. Challenger Ech., p. 205.

Type, *Schizaster claudicans* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 211.

This is a monotypic genus which has apparently not been met with since the Challenger took the specimen on which it is based, in 129 fms. in the Arafura Sea.

Moira.

A. Agassiz, 1872. Rev. Ech., pt. 1, p. 146.

Type, *Spatangus atropos* Lamarck, 1816. Anim. s. Vert., **3**, p. 32.

Mr. Agassiz proposed Moira as a modification of Moera Michelin, 1855, which was preoccupied. Michelin's removal of *atropos* from Schizaster left *S. studeri* as the type of that genus (see p. 192), but if Gray's Catalogue of the Recent Echinida or Sea Eggs in the collection of the British Museum were really published before Michelin's paper, it is hard to see how the use of Schizaster for *Spatangus atropos* can be avoided, since Gray's limitation of the name to that species is very definite. As there seems to be some room for doubt as to the exact dates of publication of the names involved, I prefer to keep Moira in its customary place, especially as the name may ultimately be preserved on the list of *nomina conservanda*.

Nothing has hitherto been published regarding the pedicellariae of this genus. I have therefore examined the material in the M. C. Z. collection with some interesting results, but these do not warrant any generalizations as to generic characters shown by the pedicellariae. Specific characters in the genus are not well marked and the geographical range of the different forms is imperfectly known. The Siboga took four small spatangoids, referred by de Meijere to Moira, near Timor in shallow water, and I may record that in 1913 the Queens-

land Museum at Brisbane contained a tray of partly disintegrated Moiras which were labeled as having been taken at the Capricorn Islands, on the Queensland coast.

Key to the Species of Moira.

Interambulacra 2 and 3 within the peripetalous fasciole considerably and abruptly depressed; posterior end of test nearly or quite vertical.
- Phyllodes rather small and actinal ambulacra narrow and not very bare; tubercled portion of sternum less than two thirds as wide as long, its anterior end less than one third of test-length from anterior end of test (within the furrow of ambulacrum III) . . . . . *atropos.*
- Phyllodes and actinal ambulacra large and bare; tubercled portion of sternum three fourths as wide as long, its anterior end two fifths of test length from anterior end of test (within furrow) . . . . . *clotho.*

Interambulacra 2 and 3 within the peripetalous fasciole slightly and not abruptly depressed; posterior end of test somewhat concave, its lower margin projecting further aborally than its upper portion . . . . . *stygia.*

Moira atropos.

Spatangus atropos Lamarck, 1816. Anim. s. Vert., **3**, p. 32.
Moira atropos A. Agassiz, 1872. Rev. Ech., pt. 1, p. 146.

This species is particularly characteristic of the coast of the southeastern United States from Beaufort, N. C., where it is abundant, to Texas. I have seen bare tests from Jamaica and it is also recorded from Guadeloupe, but it must be rare in the West Indies for it was not met with by the Blake.

Tridentate pedicellariae are very common but I failed to find any globiferous, or any other kind. The tridentate are not characteristic or peculiar in any way; the valves are somewhat compressed near base but the blade is rather flat and is a little wider distally than near base; the valves range from those about .30 mm. long, .08 mm. wide at base and .07 mm. near tip to those .75–.80 mm. long, .10 mm. wide at base and only .07 or .08 mm. wide near tip.

Moira clotho.

Moera clotho Michelin, 1855. Rev. Mag. Zool., p. 247.
Moira clotho A. Agassiz, 1872. Rev. Ech., pt. 1, p. 147.

Plates 146, fig. *23*; 156, figs. *5–7*.

This is the West coast species found from the Gulf of California southward. As it has never been figured, photographs of the bare test from different points of view are shown (Pl. 156, figs. *5–7*). Of pedicellariae, I was surprised

to find only 1 tridentate, and that very small, and 2 globiferous. The tridentate is similar to those of *atropos* but the valves are only about .18 mm. long. The globiferous are very interesting. The stalk has a remarkable flaring "limb" (Pl. 146, fig. *23*) with a perfectly smooth edge, quite unlike anything I have ever seen in pedicellarian stalks. The valves are .70–.75 mm. long and resemble those of *Schizaster orbignyanus* and *canaliferus* as figured by Mortensen (1907. Ingolf Ech., pt. 2, pl. 14, figs. 2, 8) but there is even less distinction between blade and base, and the apophysis reaches well up above the middle of the valve.

Moira stygia.

Moera stygia A. Agassiz, 1872. Bull. M. C. Z., **3**, p. 58.
Moira stygia A. Agassiz, 1872. Rev. Ech., pt. 1, p. 147.

This species is recorded from the Red Sea and from Zanzibar. Examination of the only specimen in the M. C. Z. collection, though prolonged, failed to reveal a single pedicellaria. But the specimen is old and dry and has lost many of its spines.

SPATANGIDAE Gray.

This is the largest of the families of spatangoids and includes all those forms with more or less developed petals, which also have a subanal fasciole. But in many cases the petals are imperfectly developed and differ little apparently from the condition shown by the Palaeopneustidae. In such cases, however, there is reason to believe that the petals were formerly more perfectly petaloid and that the present condition is the result of continued specialization. Yet it must be granted at once that it is highly improbable that the petals of Linopneustes are in any particular essentially different from those of Archaeopneustes and Palaeopneustes. As for the subanal fasciole it is a well-known fact that in Meoma the subanal fasciole is practically wanting and in certain individuals of Spatangus it may entirely disappear with age.

The pedicellariae of the Spatangidae are exceedingly varied and there are greater differences between some of the genera within the family than there are between these genera and some of the genera in other families. In many cases ophicephalous pedicellariae are wanting and in others they seem to be present only on young specimens, so we may ultimately find that the presence or absence of ophicephalous pedicellariae will prove a useful character in determining relationships within the family. In certain genera some of the pedicellariae

assume bizarre forms, either of stalk or of valves. Occasionally there may be only two valves and in rare cases there may be four, five, six, or even eight valves, but such pedicellariae seldom throw much light on intergeneric relationships.

While recognizing no fewer than twenty genera, it must be admitted that they are of unequal value and by no means always easy to distinguish. Yet the future is likely to see more rather than fewer genera recognized, even if no new species are discovered. Those genera which possess an internal fasciole are probably the most highly specialized sea-urchins now existent, unless we except Pourtalesia and its allies. The absence of a peripetalous fasciole in seven of the genera seems an unquestionably secondary character and not the primitive condition.

Key to the Genera of Spatangidae.

No internal fasciole.
  Peripetalous fasciole present, at least in part.
    Petals well formed, and in adults depressed, often flush in young specimens.
      Peripetalous fasciole a single undivided band.
        Posterior end of test not projecting as a subanal snout encircled by the subanal fasciole.
          Ambulacrum III dorsally more or less distinctly sunken and petaloid; posterior petals often the shortest . . . . . *Brissopsis.*
          Ambulacrum III little or not at all sunken and not at all petaloid; posterior petals usually the longest.
            A distinct anal fasciole arises from subanal on each side of the periproct.
              Ambulacrum III more or less differentiated abactinally, often depressed; subanal plastron not projecting.
                Big primary tubercles present within peripetalous fasciole in interambulacra 1 and 4, and may be in 2, 3 and 5 . . . . . *Plagiobrissus.*
                No big primary tubercles within peripetalous fasciole . . . . . *Metalia.*
              Ambulacrum III not at all differentiated abactinally, perfectly flush with adjoining interambulacra; subanal plastron projecting downward or backward more or less distinctly . . . . . *Rhynobrissus.*
            No anal fasciole.
              Subanal fasciole complete, surrounding a distinct subanal plastron . . . . . *Brissus.*
              Subanal fasciole incomplete; no distinct subanal plastron . . . . . *Meoma.*
        Posterior end of test projecting as a subanal snout encircled by the subanal fasciole . . . . . *Cionobrissus.*

Peripetalous fasciole in some places double, triple or even multiple . *Plethotaenia.*
Petals flush, often not distinctly petaloid.
Paired ambulacra not petaloid or if so, widely open at end and not abruptly limited by peripetalous fasciole.
Test rather high, v. d. .40–.50 length, highest at apical system . *Linopneustes.*
Test more flattened, v. d. .30–.40 length, highest back of apical system . . . . . *Elipneustes.*
Petals short well formed with definite interporiferous areas and terminated by the peripetalous fasciole.
Posterior petals as wide near their rounded tips as at middle; ambulacrum III not depressed and anterior ambitus evenly convex . *Eupatagus.*
Posterior petals much narrower near their bluntly pointed tips than near middle; ambulacrum III more or less depressed, at least at ambitus . . . . . *Gymnopatagus.*
No peripetalous fasciole.
Sternum more or less well developed, much longer than wide, fully covered with tubercles, the tuberculated portion extending more than half-way from subanal plastron to peristome.
At least ten distal pore-pairs developed in anterior series of petals II and IV; genital pores 4; labrum short and wide . . . . . *Spatangus.*
Only 4–8 distal pore-pairs developed in anterior series of petals II and IV; genital pores 3; labrum long and narrow . . . . . *Gonimaretia.*
Sternum small, wide, the tubercles confined to the posterior end or at least not extending half-way from subanal plastron to peristome; labrum very long and narrow.
Periproct nearly or quite flush with posterior end of test; genital pores 4 . . . . . *Maretia.*
Periproct deeply sunken and overhung by posterior end of test; genital pores 3 . . . . . *Pseudomaretia.*
An internal fasciole present.
Peripetalous fasciole present . . . . . *Breynia.*
No peripetalous fasciole present.
Large, deeply sunken primary tubercles present in interambulacra on both upper and lower surfaces; labrum very long and narrow; sternum with tubercles confined to posterior part.
Petals I and V well formed . . . . . *Lovenia.*
Petals I and V not at all petaloid . . . . . *Pseudolovenia.*
No large deeply sunken primary tubercles; labrum short and wide; sternum well covered with tubercles . . . . . *Echinocardium.*

Brissopsis.

Agassiz, 1840. Cat. Syst. Ect., p. 5 (*nomen nudum*).
Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), 8, p. 14.

Type, *Brissus lyrifer* Forbes, 1841. British Starfishes, p. 187.

Not only is this one of the most wide spread of spatangoid genera, but it is one of the most perplexing from a taxonomic point of view. The species are

exceedingly difficult to separate from each other satisfactorily and there has been much confusion as a consequence. When the Revision of the Echini was published, Mr. Agassiz recognized but two species, *luzonica* from the East Indies and *lyrifera* from the eastern Atlantic. Since then no fewer than eleven Recent species have been proposed. The attempt to recognize these thirteen species and prepare a key by which they could be distinguished has led me finally, after examining more than 400 specimens, to the conclusion that eight species are all that can be really distinguished and it is possible that one or two of these are simply extreme variants of the most wide spread species. As for the genera Kleinia and Toxobrissus, it seems hopeless to try to separate them from Brissopsis.

Mortensen's careful work (1907, INGOLF Ech., pt. 2, p. 152–168) has revealed good specific characters not hitherto recognized and has resulted in making clear the limits of *lyrifera* and the separation therefrom of at least three recognizable forms. I cannot follow him, however, in attempting to differentiate a variety *capensis* for the form of *lyrifera* found near the Cape of Good Hope. I think we have here, as in the case of *Brisaster fragilis*, a north Atlantic species occurring in South African waters. Such cases demand more careful study and much more abundant material before their true status can be determined. The East Indian species *luzonica* is even more variable than its Atlantic congener and its geographic range, as far east as Hawaii, is even greater. In our preliminary reports (1907, Bull. M. C. Z., **50**, no. 8 and **51**, no. 5) Mr. Agassiz and I not only attempted to distinguish *oldhami* from *luzonica*, but described from a single specimen, a third species, *circosemita*. Since then Dr. Koehler has published his important report on Indian spatangoids (1914, Ech. Indian Mus.: Spat.) in which he recognizes six species of Brissopsis from the Indo-Pacific region. His descriptions are most detailed and his figures excellent and very useful. A careful study of all the specimens accessible, in the light of Mortensen's and Koehler's publications, satisfies me that *oldhami* is only a form of *luzonica* which is not even worthy of varietal rank; that *circosemita* is a young *luzonica* with certain individual peculiarities that do not warrant the retention of the name; that *duplex*, *lemonnieri*, and *bengalensis* are all best referred to *luzonica;* and that *parallela* may possibly prove to be only an extreme variant of the same species. The three forms separated from *lyrifera* by Mortensen, *alta*, *atlantica*, and *elongata* are recognizable but I am not sure as to their real status; *alta* may be a hybrid between a Brissopsis and *Hypselaster limicolus*, *atlantica* simply a variant of *lyrifera* and *elongata*, a variant in another direction. It is evident therefore that more material and more study are necessary before

the number of species in the genus can be considered as settled. The pedicellariae are of little use in identifications of Brissopsis species, for they are very variable and not particularly distinctive, but no study of the limits of their diversity has yet been made. Even such apparently fundamental characters as the number of plates in the subanal plastron, and the number of penicillate tube-feet there, are subject to individual diversity to a perplexing degree, while the form and direction of the petals is aggravatingly variable. In the face of all the difficulties, it is not strange that the following key is unsatisfactory.

Key to the Species of Brissopsis.

Posterior petals divergent, primary tubercles approaching madreporite in interambulacrum 5.
- Test truncate posteriorly; periproct vertical, scarcely visible from above; petals I and V shorter than II and IV.
  - Test more or less flattened; apical system subcentral; anterior margin of labrum .25–.30 test-length from anterior margin of test . . . . . *lyrifera.*
  - Test more or less globular; apical system anterior; margin of labrum less than .20 test-length from anterior margin of test . . . . . *alta.*
- Test sloping posteriorly; periproct oblique, plainly visible from above; petals I and V about as long as II and IV . . . . . *columbaris.*

Posterior petals more or less parallel or merged proximally.
- Posterior petals parallel, close together, not curving outward distally . . . . . *parallela.*
- Posterior petals near together proximally but curving outward distally.
  - Petals very large; petaloid area covering most of abactinal surface; its length is .70–.90 test-length and its width .75–.90 of its own length . . . . . *pacifica.*
  - Petals smaller; petaloid area about .66 test-length or less.
    - First ambulacral plate in subanal fasciole is no. 7; 5 ambulacral plates included in subanal plastron; anterior petals directly diverging . . . *elongata.*
    - First ambulacral plate in subanal fasciole is no. 6; anterior petals ascending.
      - Posterior end of test markedly oblique so periproct is more or less dorsal . . . . . *atlantica.*
      - Posterior end of test usually truncate so periproct is scarcely visible from above . . . . . *luzonica.*

Brissopsis lyrifera.

Brissus lyrifer Forbes, 1841. British Starfishes, p. 187.
Brissopsis lyrifera Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), **8**, p. 14.

The geographical range of this well-known species is remarkable, extending as it does from Denmark Strait and southern Iceland through the seas of northern and western Europe into the Mediterranean, and though apparently

absent on the West African coast appearing again in South African waters. Bathymetrically it occurs out to about the 200-fathom line. As Mortensen has shown, there are no authentic records, for the American coast or the West Indies.

Brissopsis alta.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 159.

Dr. Mortensen does not refer to the possibility that this is a hybrid but it seems there is some basis for suspecting it. All of the forty-seven specimens in the M. C. Z. collection are from Blake Station 49, the type locality for *Hypselaster limicolus*, and all other known specimens are from stations where *limicolus* also was taken. This fact seems significant.

Brissopsis columbaris.

A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 82.

The range of this species was known hitherto as from the northern side of the Gulf of Panama to the vicinity of Cape St. Lucas, Lower California, at depths of 491–1793 fms. The following stations extend the range southward and into shallower water.

Station 2792. Off Cape San Lorenzo, Ecuador. Bott. temp., 42.9°. 401 fms. Gn. m.

Station 2793. Off Cape San Francisco, Ecuador. Bott. temp. 38.4°. 741 fms. Gn. m.

Station 4631. Off Mariato Point, Panama. Bott. temp. 38°. 774 fms. Gn. s.

Bathymetrical range, 401–774 fms. Extremes of temperature, 42.9°–38°. Twenty-eight specimens.

Brissopsis parallela.

Koehler, 1914. Ech. Indian Mus. Spat., p. 213.

So far as the material permits of a decision, this seems like a well-marked species, but it is known from only four specimens, three fragmentary, from four stations in the eastern part of the Bay of Bengal in 185–705 fms., a region in which *luzonica* is well known to occur. Its relation to that species still needs elucidation.

Brissopsis pacifica.

Toxobrissus pacificus A. Agassiz, 1898. Bull. M. C. Z., **32**, p. 83.
Brissopsis pacifica Mortensen, 1907. Ingolf Ech., pt. 2, p. 168.

Plate 155, fig. *1*.

The following stations extend the known range of this species considerably to the northward and into much shallower water. It was previously known from the Gulf of Panama and near Lower California in 182–782 fms. The specimen figured is the largest example of this species I have seen, and its petaloid area is relatively the smallest.

Station 2925. Off southern California. Bott. temp. 42.9°. 339 fms. M.
Station 2936. Off southern California. Bott. temp. 49°. 359 fms. M.
Station 2952. Off southern California. Bott temp.? 57 fms. Brk. sh., r.
Station 2973. Off southern California. Bott. temp. 54°. 68 fms. Gn. m.
Station 2979. Off southern California. Bott. temp.? 388 fms. Gn. m.
Station 3018. Gulf of California. Bott. temp. 63.3°. 36 fms. Gy. s., brk. sh.
Station 3031. Gulf of California. Bott temp. 63.8°. 33 fms. Br. m.
Station 3034. Gulf of California. Bott. temp. 63.5. 24 fms. Gy. m.
Station 3035. Gulf of California. Bott. temp. 62°. 30 fms. Gy. m.
Station 3037. Gulf of California. Bott. temp. 65.2°. 20 fms. Gn. m.
Bathymetrical range, 20–388 fms. Extremes of temperature, 65.2°–42.9°.
Eighty-two specimens.

Brissopsis elongata.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 163.

This species is recorded only from Puerto Cabello, Venezuela, and from the west end of Porto Rico in 25 fms.

Brissopsis atlantica.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 160.

There are numerous specimens of this species in the M. C. Z. collection from various stations along the southeastern coast of the United States. Recently (1913. Mitt. Zool. Stat. Neapel, **21**, p. 29) Mortensen has recorded

this form from the Mediterranean Sea, giving it the varietal name *mediterranea*, but the varietal characters seem insignificant, and my skepticism as to the validity of the species is increased by its occurrence in the Gulf of Naples where *lyrifera* is not rare.

Brissopsis luzonica.

Kleinia luzonica Gray, 1851. Ann. Mag. Nat. Hist., (2) **7**, p. 133.
Brissopsis luzonica A. Agassiz, 1872. Rev. Ech., pt. 1, p. 95.

Plates 152, figs. *5–8*; 155, figs. *2*, *3*.

The large series of Brissopsis in the ALBATROSS collections from Hawaii and Japan has been the object of much study in an attempt to separate *B. oldhami* from *B. luzonica*. The differences mentioned in the preliminary papers (1907. Bull. M. C. Z., **50**, no. 8 and **51**, no. 5) do not prove constant; the most typical *luzonica* grade by imperceptible degrees into typical *oldhami*, and I have finally decided that there is only one species in the series before me. Furthermore I am satisfied that the peculiarities of the young Brissopsis, to which the name *circosemita* was given are not specific but are individual and that the specimen is best treated as a young *luzonica*. I have, however, given figures (Pl. 152, figs. *5–8*) showing the characters on which the supposed species was based, for they will be useful in working out the growth-changes in *luzonica*. For comparison with *B. pacifica* photographs of a typical adult (Pl. 155, figs. *2*, *3*) are also given.

Station 3737. Near entrance to Port Heda, Japan. Bott. temp.? 161–167 fms. Gn. m., vol. s.

Station 3824. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 49.5°. 222–498 fms. Cor. r., brk. sh.

Station 3826. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 41.5°. 371–430 fms. Gy. m., cor. r.

Station 3836. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 48°. 238–255 fms. Br. gy. m., s.

Station 3839. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 46.3°. 259–266 fms. Lt. br. m., s.

Station 3842. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 40.5°. 495–506 fms. Fne. br. s., m., r.

Station 3863. Between Molokai and Maui, H. I. Bott. temp. 60°–61°. 127–154 fms. Brk. co., crs. gr., r.

Station 3892. Off north coast of Molokai, H. I. Bott. temp. 42.5°. 328–414 fms. Fne. gy. s.

Station 3908. Off south coast of Oahu, H. I. Bott. temp. 43.8°. 304–308 fms. Fne. w. s., m.

Station 3912. Off Diamond Head, Oahu, H. I. Bott. temp. 43°. 310–334 fms. Fne. gy. s., m.

Station 3916. Off Diamond Head, Oahu, H. I. Bott. temp. 44°. 299–330 fms. Gy. s., m.

Station 3917. Off Diamond Head, Oahu, H. I. Bott. temp. 44°. 294–330 fms. Gy. s., m.

Station 3918. Off Diamond Head, Oahu, H. I. Bott. temp. 44.5°. 257–294 fms. Wh. s., m.

Station 3992. Off Mokuaeae Islet, Kauai, H. I. Bott. temp. 39.6°. 528 fms. Fne. gy. s., m.

Station 3997. Off Ukula Point, Kauai, H. I. Bott. temp. 41°. 418–429 fms. Fne. gy. s., br. m.

Station 4028. Off Ukula Point, Kauai, H. I. Bott. temp. 40°. 444–478 fms. Gy. s., glob.

Station 4044. Off Kawaihae Light, Hawaii, H. I. Bott. temp. 47°. 198–233 fms. Fne. gy. s.

Station 4070. Off Puniawa Point, Maui, H. I. Bott. temp. 70.8°. 45–52 fms. Fne. gy. s.

Station 4083. Off Puniawa Point, Maui, H. I. Bott. temp. 48.8°–46.7°. 238–253 fms. Gy. s.

Station 4131. Off Hanamaulu, Kauai, H. I. Bott. temp. 43.7°. 257–309 fms. Fne. gy. s.

Station 4132. Off Hanamaulu, Kauai, H. I. Bott. temp. 46.8°. 257–312 fms. Fne. gy. s., m.

Station 4906. Southwest of Koshika Islands, Eastern Sea. Bott. temp. 43.4°–42.6°. 369–406 fms. Gy. glob. oz.

Station 4907. Southwest of Koshika Islands, Eastern Sea. Bott. temp. 42.6°. 406 fms. Gy. glob. oz.

Station 4911. Southwest of Koshika Islands, Eastern Sea. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4912. Southwest of Koshika Islands, Eastern Sea. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4913. Southwest of Koshika Islands, Eastern Sea. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4915. Southwest of Koshika Islands, Eastern Sea. Bott. temp. 41.9°. 427 fms. Gy. glob. oz., brk. sh.

Station 4956. Off Mizimoko Shima Light, Japan. Bott. temp. 37.5°. 720 fms. Gn-br. m., fne. gy. s., for.

Station 4957. Off Mizomoko Shima Light, Japan. Bott. temp. 39.8°. 437 fms. Gn-br. m., fne. gy. s., for.

Station 4966. Off Shio Misaki Light, Japan. Bott. temp. 44.1°. 244–290 fms. Br. m., s., for.

Station 4968. Off Shio Misaki Light, Japan. Bott. temp. 45.7°. 253 fms. Dk. gy. s., br. m., brk. sh.

Station 4970. Off Shio Misaki Light, Japan. Bott. temp. 39.1°. 500–649 fms. Br. m., bk. s., sh.

Station 4980. South from Hamamatsu, Japan. Bott. temp. 39°. 507 fms. Br. m., fne. s., for.

Station 5053. Off Omai Saki Light, Japan. Bott. temp. 34.9°. 503 fms. Gn. m.

Station 5054. Off Omai Saki Light, Japan. Bott. temp. 45.3°. 282 fms. Gn. m., brk. sh., for.

Station 5055. Off Omai Saki Light, Japan. Bott. temp. 56.6°. 124 fms. Gn. m., gy. s., brk. sh., p.

Station 5082. Off Omai Saki Light, Japan. Bott. temp. 37.7°. 662 fms. Gn. m., fne. s., glob.

Station 5083. Off Omai Saki Light, Japan. Bott. temp. 38.1°. 624 fms. Fne. gy. s., glob.

Station 5087. In Sagami Bay, Japan. Bott. temp. 37.5°. 614 fms. Gn. m.

Station 5088. In Sagami Bay, Japan. Bott. temp. 41.8°. 369–405 fms. Gn. m.

Station 5091. In Uraga Strait, Japan. Bott. temp. 47.6°. 197 fms. Gn. m., crs. bk. s., p.

Station 5092. In Uraga Strait, Japan. Bott. temp. 56.3°. 70 fms. Crs. bk. s.

Bathymetrical range, 45–720 fms. Extremes of temperature, 70.8°–34.9°. One hundred and forty-six specimens.

Plagiobrissus.

Pomel, 1883. Class. Meth. Ech., p. 29.

Type, *Spatangus pectoralis* Lamarck, 1816 = *Echinus grandis* Gmelin, 1788. Linné, Syst. Nat., ed. 13, 1, pt. 6, p. 3200.

This group is rightfully distinguished from Metalia as it not only differs markedly from that genus structurally, but its geographical distribution is wholly different. Metalia is an Indo-Pacific genus while Plagiobrissus is confined to certain parts of the tropical Atlantic and of the western Mediterranean. Louis Agassiz first recognized the group but his name Plagionotus being preoccupied, Mr. Agassiz, in the Revision, simply merged the component species with Metalia of Gray, the most nearly allied genus, and there the matter has since rested, except that Pomel, in his remarkable but generally ignored work, suggested the name Plagiobrissus as a substitute for Plagionotus. It is regrettable that the species of this genus are little known. The West Indian species seems to be fairly common at the Bahamas, but the African species is no better known than when first described fifty years ago, and the Mediterranean species is also very rare.

The pedicellariae in this genus are notable and are abundant. The characteristic form is a highly modified "long, globiferous," in which the valves have become almost solid masses of calcareous matter. A normal form of globiferous pedicellaria may also be present and rostrate pedicellariae are common. Tridentate pedicellariae with long valves having coarsely serrate or dentate margins occur and smaller tridentate and triphyllous are also present. Ophicephalous pedicellariae may be present or wanting.

Key to the Species of Plagiobrissus.

Large primary tubercles present in dorsal parts of interambulacra 1, 2, 3 and 4.
- Peristome squarish, rarely more than twice as wide as long . . . . . *grandis.*
- Peristome crescentic, more than twice as wide as long . . . . . *africanus.*

Large primary tubercles on dorsal surface, confined to interambulacra 1 and 4 . . . . . *costae.*

Plagiobrissus grandis.

Echinus grandis Gmelin, 1788. Syst. Nat., ed. 13, 1, pt. 6, p. 3200.
Metalia pectoralis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 144. *Et auct. omnes post.*
Plagiobrissus pectoralis Pomel, 1883. Class. Meth. Ech., p. 30.

Plate 146, figs. *21*, *22*.

It is hard to see why Mr. Agassiz chose to ignore Gmelin's highly appropriate name in favor of Lamarck's name of twenty years later. No echinoid so

well deserves the name *grandis* as does this magnificent spatangoid. The best specimens in the M. C. Z. collection are about 215 mm. long, 165 mm. wide and 55 mm. high and the dorsal primary spines are 75–90 mm. in length. When in perfect condition with all its long, dorsal primary spines intact, it is certainly the handsomest and most remarkable of shallow-water spatangoids. It must be fairly common at Nassau, Bahama Islands, as I have seen a number of specimens taken "on a bank, outside the bar" at that port. It is also known from Tampa, Florida, and Bahia, Brazil, but I have not found it at Jamaica or Tobago and the BLAKE did not meet with it on any of her voyages.

The pedicellariae of this species are very striking. In general they resemble those of *P. costae* as figured by Mortensen but they are obviously different. No ophicephalous or normal globiferous were found on the specimens examined. The curious "long globiferous" occur abundantly in the posterior ventral ambulacra, but they are not covered by dark colored tissue as they are in *costae*. The valves are nearly a millimeter long (Pl. 146, fig. *21*) and do not meet at tip as usual but overcross there (Pl. 146, fig. *22*). Rostrate pedicellariae are very common; while they resemble those of *costae*, the valves are shorter and have a much wider base; each valve is about .75 mm. long, with the base about .35 mm. high and equally wide. Tridentate pedicellariae are rare, only one being found. It had valves 1.25 mm. long, with narrow blades having very coarsely dentate edges; they resemble those of *Brissus unicolor* (see Mortensen, 1913. Mitt. Zool. Stat. Neapel, **21**, pl. 4, figs. 19 and 27) more than they do those of *P. costae*. Triphyllous pedicellariae are also hard to find and only one was seen. It had valves about .25 mm. long and might perhaps better be considered a small tridentate; but the form of the valves was similar to what is seen in *P. costae* though the blade is markedly narrower.

Plagiobrissus africanus.

Plagionotus africanus Verrill, 1871. Trans. Conn. Acad., **1**, p. 569.

I have never seen a specimen of this species and have found little in the original description by which to distinguish this West African species from West Indian specimens of the same size. The type locality is Sherboro Island, Sierra Leone.

Plagiobrissus costae.

Metalia costae Gasco, 1877. Rendic. Accad. Sci. Napoli, **16**, fasc. 2, p. 4.

This species is as yet known only from the Gulf of Naples where it is far from common. It has been well figured and the pedicellariae described in

detail by Mortensen (1913. Mitt. Zool. Stat. Neapel, **21**, p. 32–34, pl. 3). To judge from the photographs the form of the test is much more like that found in Metalia than like that of *P. grandis*.

Metalia.

Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 51.
Type, *Spatangus sternalis* Lamarck, 1816. Anim. s. Vert., **3**, p. 31.

As the pedicellariae of this genus have scarcely been examined hitherto, I have given particular attention to them. They show little diversity as neither ophicephalous nor globiferous were found, nor did I see any which could be called triphyllous. The rostrate are present in some numbers and tridentate in various forms are abundant, but I fail to find any generic characters in either. Careful reading of Bell's description shows no reason for recognizing his proposed genus Eobrissus; it seems better to put the new species in Metalia.

Key to the Species of Metalia.

Apical system distinctly anterior.
- Petals I and V more or less confluent; no primary tubercles at dorsal proximal end of interambulacrum 5 . . . . . *sternalis.*
- Petals I and V not at all confluent; primary tubercles present at dorsal proximal end of interambulacrum 5.
  - V. d. less than ½ test-length; apex .33–.40 test-length from anterior margin; sternum with a single median point where it meets subanal fasciole . . . *spatagus.*
  - V. d. more than ½ test-length; apex less than .30 test-length from anterior margin; sternum with 2 points (3–5 mm. apart) where it meets subanal fasciole . . . . . *dicrana.*

Apical system subcentral . . . . . *townsendi.*

Metalia sternalis.

Spatangus sternalis Lamarck, 1816. Anin. s. Vert., **3**, p. 31.
Brissus (Metalia) sternalis Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 51.

Plate 146, fig. *30.*

From Zanzibar to the Hawaiian and Society Islands is the range of this well-known species. It is one of the most diversiform of spatangoids and its growth-changes are very remarkable. Only the examination of many specimens can convince one that the younger individuals are really the same species as the full-grown adults. Mr. Agassiz called attention to this matter in the

Revision and described some of the growth-changes. It may be added here that in half-grown specimens only five ambulacral plates, with five large penicillate tube-feet enter the subanal fasciole on each side, while in specimens 150 mm. long, there may be ten such plates, with nine big tube-feet, on each side. Intermediate stages may be found on specimens of intermediate size. The number of ambulacral plates may be different on the two sides in these intermediate specimens. Owing to Bolau's (1874. Arch. f. Naturg., 40, 1, p. 177) failure to give any data regarding the subanal plastron and fascioles, I am unable to satisfy myself as to his proposed species *Brissus sternaloides*, but suspect it is a growth-stage or an individual variant of the present species. It may, however, be a true Brissus.

The pedicellariae of this species show much diversity in specimens of different size. In half-grown individuals the tridentate all have three valves, measuring .25–.40 mm. in length, while in adults, these pedicellariae have two–six, usually five valves which are from .35 to 1.50 mm. long. Bidentate pedicellariae (Pl. 146, fig. *30*) are not rare in a big specimen from Mauritius, but they are of small size and resemble those of certain clypeastroids. In the large tridentate (or quadri- and quinquidentate), the valves are narrow, coarsely serrate or dentate on the margin and more or less expanded at tip. The rostrate pedicellariae are not distinctive but the blades are not expanded at the tip; in small individuals, the rostrate valves are .35–.55 mm. in length, while in adults, they are .75–.85 mm. long. It is evident that in this species growth-changes in the test are accompanied by growth-changes in the pedicellariae.

Metalia spatagus.

Echinus spatagus Linné, 1758. Syst. Nat., ed. 10, p. 665.
Metalia maculosa A. Agassiz, 1872. Rev. Ech., pt. 1, p. 144.
Metalia spatagus Lovén, 1887. Ech. Linn., p. 162.

The geographical distribution of this species is remarkable for there seems to be no doubt that it occurs at Panama and at Cape St. Lucas, Lower California, as well as from Hawaii to Mauritius and from the Society Islands to Sagami Bay, Japan. Pedicellariae are sometimes very rare and are seldom abundant apparently, but specimens from different localities show much diversity in this respect. As in *sternalis*, the larger the specimen, the larger the pedicellariae. The tridentate always have three valves and only three; these, however, range in length from about .20 mm. to over a millimeter; the longer the valves

are the less is their amount of contact at tip, the smallest ones being in contact nearly the full length of the blade. Rostrate pedicellariae occur, having valves .60–.80 mm. long; these valves have the bases about 25 per cent higher than wide and the blades a little expanded at tip.

The Albatross collection contains seven specimens, of which six are from an unknown locality, but probably somewhere on the Lower Californian coast. The seventh is from Pichilingue Bay, Lower California. There is also a fragment of ambulacrum I and interambulacrum 5 from a specimen, which must have been about 120 mm. long, estimated by comparison of fragment with the same area in a complete adult. This is an exceptionally large size for this species. The fragment was taken at station 4149, off Modu Manu, Hawaiian Islands, in 33–71 fms.

Metalia dicrana,[1] sp. nov.

Plates 146, fig. *16;* 160, figs. *1–4.*

Length of test, 58 mm.; width at middle, where widest, 53 mm.; height at middle, where highest, 37 mm., but at apical system only 31 mm. The corresponding measurements of the bare test figured (Pl. 160, figs. *1–4*) are 62, 55, 39 and 32 mm. A much smaller specimen is relatively higher, its measurements being 40, 36, 27.5, and 24 mm. The form of the test is similar in all three specimens and will be readily understood from the figures (Pl. 160, figs. *1–4*). The apical system is very far forward and reveals four large genital pores. The anterior ambulacrum (III) is nearly or quite flush dorsally but is slightly sunken at the ambitus. Petals II and IV have about twenty pore-pairs on each side and are about 20–22 mm. long. They run out at direct right angles to the long axis of the body. Petals I and V have 25 or 26 pore-pairs on each side and are some 28 mm. long. They are divergent from the start at an angle to each other of about 50°–55°, and primary tubercles occur in interambulacrum 5 close up to the madreporite. The peripetalous fasciole is well marked, though it is so indistinct in the photograph (Pl. 160, fig. *1*). Its course shows some diversity in the three specimens; in general it may be said that there is a small but sharp and distinct re-entrant angle in interambulacra 2 and 4 and a somewhat larger one just posterior to petals II and IV, while across interambulacrum 5, the fasciole is distinctly arched towards the apex. The periproct is large, 10 mm. high by 7 mm. wide, and is situated near the

[1] Δίκρανος = two-pointed, in allusion to the posterior end of the sternum.

upper margin of the vertically truncate posterior end of the test. The subanal plastron is oblique, flat or slightly convex, about 24 mm. wide and 14 mm. high; five ambulacral plates, with four big tube-feet, enter into its composition on each side. This is the arrangement in the smallest individual also but in the specimen figured, there are only four ambulacral plates with three big tube-feet on each side. It is to be regretted that owing to an indelible stain, the composition of the subanal plastron does not show in the photographs (Pl. 160, figs. *2* and *3*). The subanal fasciole is very distinct and the anal branches arising from it, one on each side, run up nearly level with the top of the periproct. The peristome is large and very little depressed. It measures 11 mm. in width by 6.5 mm. in length and is closely covered by some thirty plates (more or fewer) of which an outer (anterior) series of eight covers more than half the peristome; these eight are much larger than the rest and the middle pair are fully 2 mm. square. The labrum is scarcely 2 mm. long but is nearly 7 mm. wide; its anterior margin is nearly straight and little projecting (Pl. 160, figs. *3* and *4*). The sternum is 24 mm. long, from the posterior margin of the labrum to the subanal fasciole. It is noticeably convex, and just back of its center where it is 18 mm. wide, it culminates in a single point. At the subanal fasciole, it culminates in *two* points 5 mm. apart. There is thus on the posterior part of the sternum a flat, triangular area, 9 mm. long and 5 mm. wide posteriorly, the corners of which are the three culminating points referred to. The whole sternum is closely covered with tubercles, largest near the margins and smallest at the culminating points. The color of test and spines is very pale brown, the fascioles scarcely darker. The smallest specimen is nearly white. The specimens are all dry.

The primary spines are for the most part 2 mm. long or less but along the margins of the petals and on the subanal plastron and sternum they are twice that. The largest spines are along the sides of the oral surface of the test where they are 5 mm. long. Pedicellariae are not very common and are to be found chiefly near periproct and subanal fasciole. No globiferous, ophicephalous, or triphyllous were found. The tridentate pedicellariae have straight narrow valves about .66 mm. long, with dentate margins. The rostrate are more characteristic. The valves (Pl. 146, fig. *16*) are rather more than half a millimeter long, the base is .25 mm. wide but not so high, and the tip of the blade is slightly expanded.

This interesting new species is based on material from three rather widely separated localities. The figured specimen, a large bare test is from Thuvu

(or Thuva) Harbor, Viti Levu, Fiji Islands, and was collected there by Mr. Agassiz, or some member of his party in 1897. The holotype (M. C. Z. 3152) was collected by Semper at the island of Panglao, Bohol Province, Philippine Islands, and came into the M. C. Z. collection in 1873. It bears Semper's label "Brissus sternalis" and Mr. Agassiz catalogued it as "Metalia sternalis." The third specimen, much smaller than the other two, was also collected by Semper but apparently at the Pelew Islands. It bears a label in an unknown hand: "Brissus maculosus Leske." The "maculosus" was subsequently scratched out and "? sternalis Lam." written below. The locality is written "Palaos." In the lower left-hand corner, in lead pencil, is lightly written "49,35 neu." In spite of these hints that the specimen might represent a new species it was catalogued as *Metalia sternalis*. The differences between these specimens and *sternalis* appear to be constant and are easily seen, especially when specimens of the two species are side by side. In *sternalis* the posterior part of the sternum is carinate, the keel connecting the median culminating point with a single similar point on the subanal fasciole. The prominence of the keel and the culminating points show great diversity and they may be indistinct and the sternum nearly flat, but I have seen no approach to the characteristic triangle of *dicrana*. It is to be regretted that the color of the bare test lent itself so poorly to photography that the figures given herewith do not show this triangle clearly.

Metalia townsendi.

Eobrissus townsendi Bell, 1904. Ann. Mag. Nat. Hist., (7), **13**, p. 236.

This species is known only from specimens taken in the Arabian Sea off Oman. Bell considers the subcentral position of the apical system a generic character but it does not seem so to me.

Rhynobrissus.

A. Agassiz, 1872. Bull. M. C. Z., **3**, p. 18.
Type, *Rhynobrissus pyramidalis* A. Agassiz, 1872, *loc. cit.*

In view of the fact that only seven specimens of Rhynobrissus are available, that they seem to represent at least four and possibly five species, and that only one is certainly adult, the present revision of the genus can scarcely be considered final! The name was originally spelt with a y in the first syllable (as above) and this spelling was retained in the Revision. In 1878 and

subsequently Mr. Agassiz spelt the name Rhinobrissus and that spelling has been used by other writers, except that Hamann in Bronn's Thier-reichs in 1904 introduced another change by putting a y instead of an i into the last syllable. What was thus originally Rhynobrissus became gradually transformed into Rhinobryssus. It is time therefore that the original spelling be restored. Duncan, without any specimens at hand, proposed a genus Neopneustes for the West Indian member of the genus. Though it is unwise, at present, to approve of this, it is possible that with sufficient material, characters of generic value might be discovered which would justify the use of the proposed name. The characters which Duncan gives are not evident in the specimen at hand, or at least have no significance. The study of the pedicellariae in this genus has been tantalizing because globiferous pedicellariae, and ophicephalous pedicellariae, occurred only in one specimen each and each of these forms is remarkably characteristic. There are few genera of Echini in which additional material for study is more urgently needed.

Key to the Species of Rhynobrissus.

Test highest posterior to apical system and sloping thence to anterior margin.
- Ambitus rounded pentangular; subanal plastron projecting backward beyond periproct . . . . . *pyramidalis.*
- Ambitus ellipsoidal; subanal plastron projecting downward but not backward beyond periproct.
  - Paired ambulacra markedly petaloid dorsally . . . . . *placopetalus.*
  - Paired ambulacra not at all petaloid dorsally . . . . . *micrasteroides.*

Test highest at apical system near anterior end but posterior end about as high; ambitus ellipsoidal; subanal plastron somewhat projecting posteriorly . . . . . *hemiasteroides.*

Rhynobrissus pyramidalis.

A. Agassiz, 1872. Bull. M. C. Z., **3**, p. 58.

Plate 146, figs. *28*, *29*.

In addition to the holotype from the China Sea, figured in the Revision, there is in the M. C. Z. collection a small spatangoid purchased of Salmin and said to be from Siam, which seems to be the young of this species. On this small specimen there are many ophicephalous pedicellariae about the subanal fasciole and these have a very characteristic form. The valves (Pl. 146, fig. *28*) are .20–.30 mm. in length with the conspicuous loops (Pl. 146, fig. *29*) .04–.07 mm. more. Besides these ophicephalous pedicellariae, I found only one

rostrate and one tridentate, no globiferous or triphyllous. The rostrate had valves about .30 mm. long, with the base .08 mm. and the blade .03–.04 mm. wide. The tridentate had moderately wide, leaf-shaped valves about .18 mm. long. In the holotype, I could unfortunately find no ophicephalous pedicellariae, nor were there any globiferous. Rostrate and tridentate are abundant, chiefly near subanal fasciole and in ventral ambulacra posteriorly. Neither is at all distinctive. The rostrate resemble those in the small specimen but the valves are .25–.80 mm. long. The tridentate have straight rather narrow valves, .25–.50 mm. long; the small ones have the blade widest at middle but in the large ones it is widest near tip. A few triphyllous pedicellariae were found; these have trowel-shaped valves about .10 mm. long.

Rhynobrissus placopetalus.

Rhinobrissus placopetalus A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 256.

Plate 152, figs. *1–4*.

Length 14 mm.; width 12 mm. at mouth, where test is widest; height at peristome, 8 mm.; at posterior end, 10 mm. The general form of the test is well seen in the figures. The apical system is subcentral in position and shows four genital pores but the right anterior is very small. The petals are subequal, a little sunken, 4 mm. long with 13 or 14 pairs of pores on each side. Ambulacrum III is not petaloid, sunken or in any way recognizable. The peripetalous fasciole though slender is well marked. The periproct is much higher than wide and is situated near the top of the truncate posterior end of the test. The subanal fasciole is very distinct and the anal branches, one on each side of the periproct, are nearly as well marked. The subanal plastron is almost vertical in position and is distinctly convex, but it can hardly be said to be protruding. It is notable that only two ambulacral plates on each side enter into the composition of the plastron (Pl. 152, fig. *4*) and there are no large tube-feet there. The sternum is narrow, about two and a half times as long as wide, and strongly carinate (Pl. 152, figs. *2*, *3*). The ambulacral plates of the oral surface are not smooth but seem to be slightly sculptured in rather strong contrast to the adjoining interambulacral plates; this may be, however, an indication of immaturity and not a specific character. The most striking features of the test are the shutting out of interambulacra 1 and 4 from the peristome, the small size of the primordial interambulacral plate in each of these areas, and the dis-

proportionately large plates of the second series (Pl. 152, fig. *3*). The peristome is well forward, little sunken, and nearly twice as wide as long (Pl. 152, fig. *3*). The labrum is small, very low (or short) and wide. The color of test and spines is pale yellowish gray.

The primary spines are minute and slender anteriorly, but are longer ventrally and posteriorly; at the rear end of the test, they are three millimeters long. The spines on the sternum are slightly spatulate at tip. Pedicellariae are fairly common but are chiefly tridentate. A few triphyllous, with little leaf-like valves, scarcely .08 mm. long, were found, and there was also one rostrate seen. No globiferous or ophicephalous pedicellariae were detected. The single rostrate seen had valves about .25 mm. long; it was not in any way distinctive. The tridentate, on the other hand, are very characteristic. The valves are .30–.40 mm. long, with the blade strongly compressed at base, much less so distally, the edges entire and smooth and the tip abruptly and strongly hooked.

It is probable that the specimens at hand of this species are all very young and give no clue to the adult size, but the specimen figured shows all the specific characters well. The shape of the test is markedly different from that of either *pyramidalis* or *hemiasteroides* but is very much like that of *micrasteroides*. The well-marked petals, however, distinguish *placopetalus* at once from the West Indian species, to which, however, it is most nearly allied.

Station 4146. Vicinity of Modu Manu, Hawaiian Islands. Bott. temp. 78.7°. 23–26 fms. Crs. co. s., for.

Station 4160. Vicinity of Modu Manu, H. I. Bott. temp. 78°. 31–39 fms. Co., corln.

Three specimens.

Rhynobrissus micrasteroides.

Rhinobrissus micrasteroides A. Agassiz, 1878. Bull. M. C. Z., **5**, p. 192.

Plate 146, figs. *26*, *27*.

The unique holotype of this species yielded just two pedicellariae. One of these was a small tridentate with no distinctive features, but the other was a globiferous pedicellaria of a very unusual and characteristic sort. The valves (Pl. 146, fig. *26*) are about .30 mm. long and markedly curved at the tip, which consists of three long, slender teeth (Pl. 146, fig. *27*). The stalk, which is a little longer than the valves has a conspicuous swelling near the base. This

is the West Indian species of the genus which Mr. Agassiz thought might become the basis of a new subgenus and which Duncan made the type of Neopneustes. But it is quite near the Hawaiian species *placopetalus*, and until we have adult material of these two species it is better to treat them as congeneric. Whether they are congeneric with *pyramidalis* is still another question.

Rhynobrissus hemiasteroides.

Rhinobrissus hemiasteroides A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 211.

I am satisfied that Tenison-Wood's species *apicatus* from the coast of Australia between Port Jackson and Moreton Bay is identical with Mr. Agassiz's from Tahiti, and Mr. Agassiz's name has a few months' precedence. Wood's specimen was 64 mm. long and hence much larger than those Mr. Agassiz studied. Whether this species is really congeneric with *pyramidalis* seems doubtful. The single specimen available had but two pedicellariae, one rostrate with valves .30 mm. long, and one tridentate with valves not quite that length, and neither was in any way characteristic.

Brissus.

Leske, 1778. Add. ad Klein, p. xx.

Type, *Spatangus brissus unicolor* Leske, 1778, *loc. cit.*

Leske proposed the name "Brissi" for the third (of four) "familia"s in the genus Spatangus, and in this group he included only the single species, no. 85, *Spatangus brissus*. If therefore the third section of Spatangus "Brissi" (equivalent of course to a subgenus) be raised to generic rank its type species must bear the specific name *brissus*. But Leske's *Spatangus brissus* was, as he himself recognized, a composite made up of at least four forms, which have since been recognized as full species, under the varietal names given by Leske. One of these *maculosus* (= *spatagus* L.) was removed to Metalia by A. Agassiz in 1872 and another *ovatus* is quite unrecognizable. Of the two remaining forms we may well choose *unicolor* as the type of the genus and as the form which must obviously retain the specific name *brissus*. The only way in which this change of name can be avoided is by regarding the word "Brissus" in Leske's "Species 85. Spatangus Brissus," as not a specific but a subgeneric name, and this course seems to do violence to Leske's obvious meaning as well as to common sense. It is curious that Leske's fourth varietal name (*latecarinatus*) was

abbreviated by Lamarck to *carinatus* and this shorter form has been in constant use for a century; but it must of course give way to the original name. The genus Brissus is common and wide spread in shallow water, throughout the tropics. Although three species were recognized by Mr. Agassiz in the Revision, I can distinguish but two, and even those two are not sharply differentiated. Aside from the differences given in the following key, the slender tridentate pedicellariae seem to furnish the only good specific character. Mr. Agassiz's *Brissus damesi* (1881. Challenger Report, p. 197) is, as he himself stated, based on such immature specimens that their generic position is quite uncertain. I have seen no specimens and am unable to give the species any place in the present work. Döderlein (1885. Arch. f. Naturg., 51, 1, p. 108) has described a species from Japan, *B. agassizii*, but as the only distinctive character he gives is based on the length of the posterior petals, a feature which is very variable in *B. latecarinatus*, I cannot distinguish this Japanese species.

Key to the Species of Brissus.

Test nearly or quite vertically truncate posteriorly, not overhanging; interambulacrum 5 little or not at all carinate dorsally . . . . . *brissus.*

Test obliquely truncate posteriorly, with periproct overhanging subanal plastron; interambulacrum 5 markedly carinate dorsally, at least in adults . . . . . *latecarinatus.*

Brissus brissus.

Spatangus brissus (var. **unicolor**) Leske, 1778. Add. ad Klein, p. xx, 182.

The combination *Brissus brissus* has not previously been used but, as explained above, must be adopted for the genotype. The present species is wide spread in the tropical Atlantic and also occurs in the Mediterranean. It is known from the Azores, Canary, and Cape Verde Islands as well as from Florida, Bermuda, and the West Indies as far south as Tobago. It is a curious fact that the largest specimens from the western Atlantic are not nearly so large as those from the eastern islands and the Mediterranean Sea. Otherwise I am unable to find any noteworthy differences. Mortensen (1913. Mitt. Zool. Stat. Neapel, 21, p. 31, 32) has fully described, with excellent figures, the varied pedicellariae of this species as shown by Mediterranean specimens. In West Indian specimens, globiferous pedicellariae may be wholly wanting; when present, the valves have the blade slope more gradually into the base than is shown in Mortensen's figure. Slender tridentate pedicellariae are rare but

a small tridentate occurs with valves .30–.35 mm. long, with entire margins. As in the Mediterranean specimens, the large tridentate pedicellariae have very conspicuous teeth on the margins of the valves. I found ophicephalous pedicellariae only on one, and that a half-grown specimen.

Brissus latecarinatus.

Spatangus brissus var. **latecarinatus**, Leske, 1778. Add. ad Klein, p. xx, 185.
Brissus carinatus Gray, 1825. Ann. Phil., **26**, p. 431.

Plate 146, fig. *15*.

This is the Indo-Pacific species of the genus and its wide range extends as far as Panama. It is true that Verrill described the Panamic species as *obesus* and Mr. Agassiz accepted this third form of Brissus in the Revision. But he clearly expresses doubt as to its validity, and I find myself unable to distinguish specimens from Panama from those of the same size from various Pacific Islands and even from Mauritius. Indeed, the characters of the fasciole and petals mentioned in the Revision as distinguishing the Atlantic from the Pacific species do not seem to be at all constant.

The pedicellariae are in general similar to those of the Atlantic species. Globiferous seem to be very rare but are usually present on or near the periproct; the valves are about half a millimeter long and closely resemble those of *brissus*. Rostrate pedicellariae, with valves like those of *brissus*, .60–.85 mm. long, are more common. Large tridentate pedicellariae are present on the periproct and on the ambulacra ventrally; the valves, which measure .37–1.75 mm., have a lower, wider apophysis and much longer teeth on the margins of the blade than in *brissus;* the marginal teeth may be one fifteenth of the length of the valve. These large characteristic pedicellariae were practically wanting on a small specimen but on the other hand, the small specimen had ophicephalous pedicellariae, which were quite lacking in the large individual examined; these pedicellariae are like those of *brissus* and the valves are about .20 mm. long with a loop .05–.10 mm. in addition. Besides the large tridentate pedicellariae, there is a very characteristic form of tridentate found on both specimens, near the mouth and on the posterior ambulacra just above the ambitus. In this form, the valves (Pl. 146, fig. *15*) .60–.80 mm. long, are slender, strongly compressed, with very thick, slightly serrate margins. They are thus very markedly different from the corresponding slender tridentate pedicellariae of

brissus. I found no triphyllous pedicellariae on either of the specimens examined.

The ALBATROSS collection contains half a dozen specimens, of which three are from an unknown locality; the largest is a bare test 165 mm. long. There is one small specimen from Laysan, H. I., and another only 9 mm. long from near Modu Manu, H. I., 26 fms. In this last the generic characters are very distinct but the specific characters are those of *brissus*. A slightly larger specimen 19 mm. long, from the Gulf of California, 7 fms. shows the beginning of the dorsal keel in interambulacrum 5 but the posterior end of the test is still vertical, as in *brissus*.

Meoma.

Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 132.
Type, *Meoma grandis* Gray, 1851, *loc. cit.*

This characteristic, shallow-water, American genus contains but two species, one in the West Indies, the other on the western coast of Mexico. The differences between these two forms, except in color and in details of the pedicellariae, are so slight and inconstant that I find even those mentioned by Mr. Agassiz in the Revision to be quite unreliable. Globiferous and ophicephalous pedicellariae are wanting in the genus, but the rostrate and tridentate are plentiful and afford some specific characters. The subanal fasciole is very incomplete and there is no real subanal plastron but whether this is a degenerate, a highly specialized, or a primitive condition can only be determined when some of the early growth-stages are known.

Key to the Species of Meoma.

Color deep blackish brown (little affected by preservation) . . . . . *grandis.*
Color reddish or yellowish brown, becoming dingy on drying . . . . . *ventricosa.*

Meoma grandis.

Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 132.

This is the species of western Mexico, particularly in the region of the Gulf of California. There are but two kinds of pedicellariae. The rostrate, which are remarkably coarse and heavy, are similar to those of Brissus, but the blades are wide and the width is little or not at all increased at the tip; the valves are strongly curved and measure .50–.80 mm. The tridentate are of two

kinds; one coarse and heavy like the rostrate, but the valves, about .65 mm. long, are nearly straight and are pointed; the other has narrow, straight, compressed valves, about half a millimeter long, the blade with serrate margins.

Meoma ventricosa.

Spatangus ventricosus Lamarck, 1816. Anim. s. Vert., **3**, p. 29.
Meoma ventricosa Lütken, 1864. Vid. Med. f. 1863, p. 120.

This is the West Indian species of the genus, ranging from Honduras to Guadeloupe. The pedicellariae are abundant and quite diversified, but neither globiferous nor ophicephalous could be found. A few triphyllous with trowel-shaped valves, like those of Spatangus, measuring .12 mm. in length, were seen but they appear to be quite rare. The tridentate are of two kinds. The smaller have the valves about half a millimeter long, rather slender but widened distal to middle and a little compressed at base of blade; the margins are nearly entire basally but distally where the valves meet each other, the margins are finely serrate. The large tridentate are quite characteristic; the valves are .75–2.20 mm. long with very coarsely and irregularly serrate or dentate margins; the largest ones are distinctly compressed basally and more or less abruptly expanded near tip where they meet. The rostrate pedicellariae also occur in two forms. In one, the valves are very strongly curved, measuring about 25% more along the arc than on the chord; on the chord they are .40–.85 mm. in length; they are very coarse and stout as in *grandis*. The other form has the valves nearly straight, rather more flattened and measuring about 1.10 mm. long, .40–.45 mm. across the base, .12–.15 mm. across the blade near its base and .20–.25 mm. across the blade near tip. On the whole the pedicellariae of *ventricosa* are quite distinctive and help to separate the species from its ally from the western coast of Mexico.

Cionobrissus.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.
Type, *Cionobrissus revinctus* A. Agassiz, 1879, *loc. cit.*

Examination of a cotype of the only species in this genus, taken near the Aru Islands in 800 fms., by the CHALLENGER, reveals only a single kind of pedicellariae. This may be called either tridentate or triphyllous; the stalk is about a millimeter long, the neck one third as much more and the valves about .20 mm. There is nothing distinctive to be noted in any feature.

Plethotaenia,[1] gen. nov.

Type, *Macropneustes spatangoides* A. Agassiz, 1883. Blake Ech., p. 64.

The Blake collected near St. Cruz and near Barbados, at depths of 82–273 fms. fragments of dead, bare tests of a spatangoid which Mr. Agassiz at first referred to *Spatangus purpureus*. In the Challenger Report he lists the same species from near Bermuda, but later he decided that the Blake specimens at any rate were not Spatangus and he accordingly described and figured them as a new species which he referred to the fossil genus Macropneustes. As Duncan (1889. Journ. Linn. Soc. Zool., **23**, p. 254) has pointed out Macropneustes is an ill-defined and unsatisfactory group, but whatever may be decided as to its fate, it does not seem possible to properly include in it the Blake species. Nor do I see how this species, so far as the unsatisfactory material at hand permits me to judge, can be referred to any other known genus and I have therefore given it a new generic name. Mortensen (1907. Ingolf Ech. pt. 2, p. 128) refers the Challenger specimen from Bermuda and various specimens from the Albatross collections, which he has seen, to the Blake species but as he says that one of the specimens has no trace of a peripetalous fasciole. the whole matter needs further investigation.

Linopneustes.

A. Agassiz, 1881. Challenger Ech., p. 167.

Type, *Palaeopneustes murrayi* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 210.

The limits and relationships of this genus are by no means satisfactorily determined. That it is nearly allied to Palaeopneustes is indicated by the general character of the test and to some extent by the pedicellariae but the presence of a subanal fasciole in Linopneustes seems a fact of too great importance to be outweighed by these resemblances. There can be little doubt that Elipneustes and Eupatagus are near allies and for the present the genus may stand near them. Koehler considers de Meijere's *Palaeopneustes spectabilis* a Linopneustes but in this I am unable to follow him because of the absence of the subanal fasciole in that species. It seems very doubtful whether *murrayi* and *excentricus* are really distinct species and I am equally in doubt whether

[1] Πλῆθος = a great number + ταινία = ribbon, band, in allusion to the number of bands in the peripetalous fasciole.

the West Indian species *longispinus* is really congeneric with them. But having thus expressed my skepticism, it seems best to let matters stand as they are for the present.

Key to the Species of Linopneustes.

Peripetalous fasciole well above ambitus and near tips of petals; poriferous areas of each petal nearly parallel or diverging distally.
- Apical system .40–.46 of test-length from anterior end . . . . . *murrayi.*
- Apical system about .30 of test-length from anterior end . . . . . *excentricus.*

Peripetalous fasciole truly marginal, far from tips of petals; poriferous areas converging distally . . . . . *longispinus.*

Linopneustes murrayi.

Palaeopneustes murrayi A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 210.
Linopneustes murrayi A. Agassiz, 1881. CHALLENGER Ech., p. 168.

The pedicellariae are very abundant in this species and the characteristic forms were figured by Mr. Agassiz on plate 43 of the CHALLENGER Report; the rostrate (fig. 6) are notable for the slender valves, .80–.90 mm. long; the slender tridentate (fig. 7) have valves .50–1.30 mm. long; and the stout tridentate (fig. 8) have valves .30–.60 mm. long with broad, somewhat flattened blades. Globiferous, ophicephalous, and triphyllous pedicellariae seem to be wanting. There are, however, minute tridentate with valves less than .20 mm. in length. The various forms of tridentate pedicellariae intergrade and show very great diversity in width of blade and in the proportion of the blade in contact with its fellows.

Comparison of the specimens collected by the ALBATROSS, a series ranging from 24 to 84 mm. in length, with cotypes of the CHALLENGER species, convinces me that they should be referred to *murrayi*, although the apical system may be only .40 of the test-length from the anterior end. On account of this tendency towards an anteriorly excentric apical system, these ALBATROSS specimens were in the preliminary report referred by Mr. Agassiz and myself to *excentricus*.

Station 4906. Southwest of Koshika Islands, Japan. Bott. temp. 43.4°–42.6°. 369–406 fms. Gy. glob. oz.

Station 4907. Southwest of Koshika Islands, Japan. Bott. temp. 42.6°. 406 fms. Gy. glob. oz.

Station 4909. Southwest of Koshika Islands, Japan. Bott. temp. 42.9°. 434 fms. Gy. glob. oz.

Station 4911. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4912. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Station 4915. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 427 fms. Gy. glob. oz., brk. sh.

Bathymetrical range, 369–427 fms. Extremes of temperature, 43.4°–41.9°.

Eleven specimens and some fragments.

Linopneustes excentricus.

De Meijere, 1902. Tijd. Ned. Dierk. Vereen, (2), 8, p. 13.

One of the cotypes of de Meijere's species is at hand, but in such a crushed condition that it is difficult to compare it accurately with *murrayi*. It does not look like the Japanese species as the test is much thinner and lighter in color. Pedicellariae are few and small and are all tridentate; in none are the valves .50 mm. long. I am unable to decide from such scanty material whether *excentricus* is valid or not.

Linopneustes longispinus.

Eupatagus longispinus A. Agassiz, 1878. Bull. M. C. Z., 5, p. 191.
Linopneustes longispinus A. Agassiz, 1880. Bull. M. C. Z., 8, p. 82.

Plate 146, fig. *12*.

Koehler (1914. Ech. Indian Mus. Spat., pl. 17, figs. 52–65) has recently published figures of the pedicellariae of what he determines as this species. But in his text he states that the specimen from which the pedicellariae were taken is in his private collection and comes from the "campagne du CHALLENGER." Evidently there is some mistake here for the CHALLENGER did not collect *longispinus*. Probably Dr. Koehler intended to write "BLAKE." At any rate his figures show well the varied forms of the triphyllous and tridentate pedicellariae, the valves of which range from .10–1.50 mm. He also figures a form of rostrate pedicellaria (his fig. 56) which I did not find, while I have found two forms of rostrate which he does not figure. In one of these the valves may be as much as two millimeters long and almost half a millimeter wide near tip; these approach and probably grade into the stout tridentate pedicellariae. The other rostrate pedicellaria is a short, stout form, with valves (Pl. 146, fig. *12*) about a millimeter long and of very characteristic shape. It is puzzling to understand why Koehler did not find either of these conspicuous rostrate pedicellariae, if

his specimen is really *longispinus*. Their absence taken in connection with his statement about his specimen having been collected by the CHALLENGER leads to the suspicion that perhaps his specimen is not *longispinus*. In view of the fact, however, that it has lost the entire lower surface, the absence from it of these particular pedicellariae is not inexplicable.

Elipneustes.

Koehler, 1914. Zool. Anz., **44**, p. 191.

Type, *Eurypneustes denudatus* Koehler, 1914. Ech. Indian Mus. Spat., p. 73.

Koehler first named this genus Eurypneustes but finding that name preoccupied, he promptly changed it to Elipneustes. The group is very near Linopneustes on the one hand and Gymnopatagus on the other. In general appearance it is more like the latter but the petals resemble more those of Linopneustes. I have seen no specimens and can add nothing to Koehler's account.

Key to the Species of Elipneustes.

Petals very long, reaching ambitus; large tubercles in interambulacra 1 and 4 abactinally not confined within peripetalous fasciole; subanal plastron not wholly ventral in position . . . . . *denudatus.*

Petals shorter, at least posterior not reaching ambitus; large tubercles in interambulacra 1 and 4 abactinally confined within peripetalous fasciole; subanal plastron ventral in position . . . . . *rubens.*

Elipneustes denudatus.

Eurypneustes denudatus Koehler, 1914. Ech. Indian Mus. Spat., p. 73.
Elipneustes denudatus Koehler, 1914. Zool. Anz., **44**, p. 191.

Many specimens of this fine species were taken by the INVESTIGATOR at a single station west from Colombo, Ceylon, in 143 fms.

Elipneustes rubens.

Eurypneustes rubens Koehler, 1914. Ech. Indian Mus. Spat., p. 89.
Elipneustes rubens Koehler, 1914. Zool. Anz., **44**, p. 191.

This species was taken twice by the INVESTIGATOR, once off the Malabar coast in 68–148 fms., and again south of Ceylon in 109–132 fms. It approaches more nearly to Gymnopatagus than does its larger congener, but still it will hardly fit into that genus.

Eupatagus.

Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), **8**, p. 9.
Type, *Eupatagus valenciennesii* Agassiz and Desor, 1847, *loc. cit.*

So far as Recent species are concerned this genus contains only the type, but Fossil species in some numbers have been assigned to it. Examination of the only specimen in the M. C. Z. collection which still has its natural covering of spines, revealed after prolonged search, only a single pedicellariae, a tridentate with valves about .42 mm. long, and with a few coarse teeth on each side. The geographical range of *E. valenciennesii* is limited, so far as we know to the region about Bass Strait, Australia, and it is far from common there, for no specimens occurred in the ENDEAVOUR collection or in any of several other collections from southeastern and southern Australia which I have examined in the past four years.

Gymnopatagus.

Döderlein, 1901. Zool. Anz., **24**, p. 22.
Type, *Gymnopatagus valdiviae* Döderlein, 1901, *op. cit.*, p. 23.

It is rather remarkable that in the nearly seventy years since Eupatagus was named no second species has been found, while within fifteen years of the first recognition of this closely allied genus, four additional species have been collected, and all the five species appear to be well defined. The genus is certainly very close to Eupatagus on the one hand and to Elipneustes on the other but it may be just as well to keep them separate, although the cordate form of the anterior end of the test which led Döderlein to establish this genus is not characteristic of most of the species.

Koehler (1914. Ech. Indian Mus. Spat., p. 98–105) has described a *Gymnopatagus sewelli,* which he thinks is very near *magnus* A. Agassiz and Clark but he does not consider the description adequate to enable him to decide whether the two are identical. On comparing his figures with our description, I find so much agreement that the identity of his species and ours seems highly probable and when our specimens are compared with his elaborate description and excellent figures, there can be no doubt left that we are dealing with the same species. It may be added that this species is the only one in which ophicephalous pedicellariae have not been found and is also the only one in which a globiferous pedicellaria has been seen. Rostrate and tridentate pedicellariae occur in all the species and occasionally furnish good specific characters.

Key to the Species of Gymnopatagus.

No large primary tubercles in interambulacrum 5 abactinally.
- Ambulacrum III more or less depressed at ambitus; petals well formed and wide; not more than 15 big primary tubercles in each of interambulacra 1 and 4 abactinally . . . . . *valdiviae.*
- Ambulacrum III not at all depressed.
  - Test widest across posterior petals, which are a little curved; no big primary tubercles in interambulacra 2 and 3 abactinally . . . . . *micropetalus.*
  - Test widest just back of apical system; posterior petals straight; big primary tubercles conspicuous in interambulacra 2 and 3 abactinally . . *pulchellus.*

Large primary tubercles present in interambulacrum 5 abactinally.
- Ambulacrum III markedly depressed at ambitus; test highest anterior to apical system; numerous big primary tubercles in interambulacrum 5 within the peripetalous fasciole . . . . . *magnus.*
- Ambulacrum III very little depressed at ambitus; test highest posterior to apical system; few (5–10) big tubercles in interambulacrum 5 abactinally . *obscurus.*

Gymnopatagus valdiviae.

Döderlein, 1901. Zool. Anz., **24**, p. 23.

This species was taken by the VALDIVIA in 412–757 fms. off the coast of Somaliland, East Africa.

Gymnopatagus micropetalus,[1] sp. nov.

Plates 146, fig. *14*; 154, figs. *4–6*; 158, fig. *5*.

Length 45 mm.; width across anterior petals, 33 mm.; width across posterior petals, 38 mm.; height back of apical system, 20 mm. The shape of the test is best shown by the figures of a smaller specimen (Pl. 154, figs. *4–6*). Genital pores 4, well developed in both specimens. Ambulacrum III flush with the rest of the test and with pores so small they can be made out only with a lens. Ambulacra II and IV imperfectly petaloid, each petal about 10 mm. long, with ten pore-pairs in posterior series but only four in anterior. Ambulacra I and V more perfectly petaloid, each petal about 14 mm. long by 3.5 mm. wide, with 16 or 17 pore-pairs on each side; these posterior petals are distinctly curved, diverging at first very evidently and then bending slightly inward (see Pl. 158, fig. *5*). There is much coarse tuberculation and some rather large-sized tubercles in interambulacra 2 and 3, but the large primary tubercles are found only in

[1] Μικρός = small + πέταλον = a petal, in allusion to the unusually small petals.

interambulacra 1 and 4, where there are about 10 in each. There are no large tubercles at all in interambulacrum 5. Just outside the large tubercles of interambulacra 1 and 4 there is a very narrow but indubitable fasciolar band, which extends across the whole interambulacrum. This indication of a peripetalous fasciole is also present in the smaller specimen where it even extends across interambulacrum 5. The posterior end of the test is so badly damaged in the larger specimens that both periproct and subanal plastron are gone. In the smaller specimen, the periproct is close to the upper margin of the nearly vertical end of the test and is distinctly wider than high. The subanal plastron is rounded triangular, nearly as long as wide, and four ambulacral plates, on each side (with three large tube-feet) enter into its composition. The subanal fasciole is very well marked. The peristome is flush with the test in both specimens; in the larger, it is about 5 mm. long by 6 mm. wide. The labrum is about 10 mm. long and 2–2½ mm. wide; it is in contact with two and a half ambulacral plates on each side. The posterior ambulacra (I and V) ventrally are each 9 mm. wide and except for a few pedicellariae are perfectly bare. The sternum, as near as I can estimate, was about 16 or 17 mm. long by 9 or 10 mm. wide, and was closely covered with primary spines. Color of test and spines (dry), dirty whitish.

The test was covered with a fairly smooth and dense coat of slender spines about 2 mm. long, but the larger primary spines are 5–10 mm. in length. Pedicellariae are abundant and varied, especially a sort of short, stout rostrate, the valves of which (Pl. 146, fig. *14*) range from .50–.85 mm. in length and terminate in a conspicuous tooth. Much smaller rostrate pedicellariae, with narrow curved valves as usual, .20–.35 mm. long, are also present but are not common. Ophicephalous pedicellariae, with valves about .25 mm. long, (besides the loop, .04–.08 mm.) are abundant, especially on the ventral ambulacra. There are also a few slender tridentate pedicellariae with valves nearly a millimeter long, the blade .05–.06 mm. wide for two thirds of its length, and abruptly expanding near tip to nearly twice that. A few triphyllous pedicellariae with short, wide valves about .08 mm. long, were also found.

The two specimens on which this species is based were supposed to be a new Maretia until careful examination revealed the presence of a peripetalous fasciole. This is, to be sure, very incomplete but in *Gymnopatagus pulchellus*, to which *micropetalus* is most nearly related, young specimens, even until over 50 mm. long have the fasciole almost exactly as it is in these specimens. While these specimens are therefore probably young, the appearance of the genital

pores indicates that they are sexually mature. That they are not the young of *pulchellus* is clearly shown by the pedicellariae, as well as by the characters given in the key above.

Station 3749. Off Suno Saki, Honshu Island, Japan. Bott. temp.? 83–158 fms. Bk. s., sh.

Station 3751. Off Suno Saki, Honshu Island, Japan. Bott. temp.? 140–148 fms. Gn. m., vol. s.

Two specimens.

Gymnopatagus pulchellus.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 254.

Plate 159, figs *2–6*.

Length 90 mm.; width across front petals 67 mm.; just back of apical system, 70 mm.; across middle of posterior petals, 68 mm.; across ends of posterior petals 63 mm.; height just back of apical system, 33 mm. The smaller specimens all show essentially the same proportions. The photographs given (Pl. 159) reveal the form of the test, the tuberculation, the character of the petals, the fascioles, the sternum, the broad ventral ambulacra and the peristome better than any description can. The subanal plastron has five ambulacral plates, with four large tube-feet entering into its composition on each side. The labrum is exceedingly long and narrow, about 16 × 3 mm. and reaches almost to the distal end of the third ambulacral plate on each side. The peripetalous fasciole, so distinct in the holotype, is very narrow and is incomplete in the smallest specimen, 57 mm. long (Pl. 159, figs. *5*, *6*). The periproct is close to the upper margin of the nearly vertical posterior end of the test; in the holotype it is about 10 mm. high by 11 mm. broad. The large dorsal primary spines are broken in every case, but judging from those most nearly perfect, they must have been over 30 mm. in length. The four genital pores are very near together and are of approximately equal size except in the smallest specimen, where the anterior pair are obviously smaller than the posterior. The smallest specimen is bright rose-color above and nearly pure white beneath, though all the spines have a brownish cast. Larger specimens are less rosy and more fawn-color. The test of the holotype is nearly uniform fawn-color, with the long spines whitish.

Pedicellariae are very abundant, but are not very distinctive. No globi-

ferous were found but ophicephalous are abundant on posterior ventral ambulacra; these valves are .22–.30 mm. long besides the loop which is .06–.12 mm. more; in form they resemble those figured by Döderlein for *G. valdiviae*. The rostrate pedicellariae are all of the ordinary type and the valves are about three quarters of a millimeter long. The triphyllous are not peculiar; the valves measure .11–.12 mm. The tridentate show a very wide range of diversity in size and form; the valves are .25–1.00 mm. long and have a very deep apophysis, the larger the valve the deeper and more conspicuous the apophysis; the width of the blade, which is dentate basally but becomes serrate distally, is from .20 to .40 of its length.

This handsome Gymnopatagus is very well marked by the form and tuberculation of the test. The fine color of the young seems to be lost when the animal is fully grown but it is even then a notably handsome spatangoid. It is worthy of mention that the peripetalous fasciole is not, at all points, a single band only. In the holotype, it forks where crossing ambulacrum III, an inner branch running parallel to the main band for 8 or 9 mm.; there are also three fragments of fasciolar bands in the same ambulacrum, 5, 6 and 9 mm. respectively above the main band. In another individual, it is in interambulacrum 5 that the fasciole gives off a branch and in this case the branch is on the outer side of the main band, and runs across ambulacrum V, a distance of nearly 20 mm. from its starting point, at a distance of about 5 mm. from the main fasciole. In a specimen about 62 mm. long, the fasciole is a complete, distinct single band, while, as already mentioned in the smallest specimen it is very narrow, not very distinct and incomplete. It is a fair deduction from these facts to say that there is a steady growth of the fasciole and of accompanying fasciolar bands from the time the individual is half grown. Probably very young individuals would not be distinguishable from Maretia.

Station 3810. Off Honolulu Light, Oahu, Hawaiian Islands. Bott. temp. 47.7°. 53–211 fms. Fne. co. s.

Station 3811. Off Honolulu Light, Oahu, H. I. Bott. temp.? 52–238 fms. Co. s., r.

Station 4045. Off Kawaihae Light, Hawaii, H. I. Bott. temp. 49°. 147–198 fms. Co. s., for.

Bathymetrical range, 52–238 fms. Extremes of temperature, 49°–47.7°.

Five specimens and a fragment.

Gymnopatagus magnus.

A. Agassiz and Clark, 1907. Bull. M. C. Z., 51, p. 133.

Plates 146, fig. *13*; 159, fig. *1*.

After the very elaborate and minute description which Koehler (1914. Ech. Indian Mus. Spat., p. 98–105) has given this species under the name *G. sewelli*, it would be quite superfluous to go into any details here. The photograph (Pl. 159, fig. *1*) of the holotype, may be of interest to compare with Koehler's Pl. 13, fig. 4. The INVESTIGATOR specimens were larger than those taken by the ALBATROSS but in spite of that fact, the differences are so trivial, it is difficult to see why Dr. Koehler did not call his specimens *magnus*. The original description of *G. magnus* is seemingly sufficient to have enabled Koehler to recognize the species in the specimens he had in hand.

As regards the pedicellariae, my observations agree with Koehler's in nearly every particular. The complete absence of ophicephalous pedicellariae is quite remarkable. I have found a single globiferous pedicellariae, the only one as yet seen on any member of the genus. The stalk was made up of parallel fibres for most of its length, somewhat as in the Arbaciidae, but was conspicuously enlarged and compact both at the base and tip; it was 5 or 6 times as long as the head. The valves (Pl. 146, fig. *13*) were about .63 mm. long, with narrow blade having several big teeth near the tip. In addition to this unique pedicellaria, I found several of the "slender-tridentate" type with 4 valves each, a variant of which Koehler does not speak.

Besides being the giant of the genus, this species is of interest because it is the only one which agrees with *valdiviae* in having the anterior ambulacrum distinctly sunken. It is a well-marked species because in addition to this characteristic test-form, it has such a large number of primary tubercles and spines dorsally in all the interambulacra. Attention should be called to the fact that *valdiviae* and *magnus* are inhabitants of much deeper water than the other members of the genus.

Station 5082. Off Omai Saki Light, Japan. Bott. temp. 37.7°. 662 fms. Gn. m., fne. s., glob.

Station 5083. Off Omai Saki Light, Japan. Bott. temp. 38.1°. 624 fms. Fne. gy. s., glob.

Four specimens.

Gymnopatagus obscurus.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 254.

Plate 158, figs. *1–4*.

Length 85 mm.; width across anterior petals, 58 mm.; across proximal part of posterior petals 67 mm.; across distal part of posterior petals, 70 mm.; height back of apical system 35 mm. The form of the test will be easily understood from the photographs (Pl. 158, figs. *1–3*) while the picture of the bare test (Pl. 158, fig. *4*) reveals the petals, the tuberculation and the four genital pores. The depression of ambulacrum III is so slight that it is only in a bare test that it becomes evident. It will be noticed that the large primaries of interambulacrum 5 are confined to the neighborhood of the tips of the petals. The periproct is large, 11 mm. wide by about 9 mm. high, and occupies most of the vertical portion of the posterior end of the test; below it lies the slightly convex but very oblique subanal plastron, into the composition of which 4 ambulacral plates (with 3 large tube-feet) on each side, enter. As will be seen from the figure (Pl. 158, fig. *2*) the sternum is relatively long and narrow (as compared with *pulchellus* for example, Pl. 159, fig. *4*) and the peristome is nearly circular. The labrum is relatively short and wide, its greatest width being about one half its length. The peripetalous fasciole shows a marked tendency to become double in places and in one specimen, it is more or less double or branched for the greater part of its course. At the tips of the anterior petals, it is particularly apt to be double. The primary spines are neither as long nor as conspicuous as in *pulchellus* and *magnus*; some of them are whole and are not 20 mm. long, and are very slender. The general color of this species is dull brown, the spines somewhat lighter.

The pedicellariae are remarkably similar to those of *pulchellus*, but the tridentate are of a more uniform type, with narrow valves, basally compressed and distally expanded; the apophyses are very deep and conspicuous; the valves are .40–1.00 mm. in length. Ophicephalous and triphyllous pedicellariae are of the same size and form as in *pulchellus*. The rostrate are all of the ordinary type and the valves are only .30–.45 mm. long. No globiferous pedicellariae were seen.

This species is remarkably near to the Japanese species *micropetalus* in the form of the test, the appearance of the posterior petals and the composition of the subanal plastron. But it differs markedly in the anterior petals, the

labrum, and the presence of large primaries in interambulacrum 5, while the pedicellariae also offer some differences. It is easily distinguished from its Hawaiian congener *pulchellus* by the form and tuberculation of the test, the labrum and sternum, and the composition of the subanal plastron.

Station 3912. Off Diamond Head Light, Oahu, Hawaiian Islands. Bott. temp. 43°. 310–334 fms. Fne. gy. s., m.

Station 4081. Off Puniawa Point, Maui, H. I. Bott. temp. 51.4°. 202–220 fms. Gy. s., for.

Seven specimens and a fragment.

Spatangus.

O. F. Müller, 1776. Zool. Dan. Prod., p. 236 (*Spatagus*).

Type, *Spatangus purpureus* O. F. Müller, 1776, *loc. cit.*

There seems to be no doubt that in the first post-Linnaean use of this generic name, it was spelled without the n, conforming to Linné's specific name in *Echinus spatagus*. But since such spelling is etymologically incorrect and has been avoided by all subsequent writers, it would be highly objectionable to revive it, and I therefore treat Müller's early spelling as a slip of the pen. Lambert's suggestions regarding Spatangus and other echinoid names, I cannot discuss because he harks back to pre-Linnaean authors. The changes he proposes are most annoying and quite unnecessary, and in the case of Spatangus at least contrary to both the letter and spirit of the International Code.

The genus is a well-defined and wide-spread group, occurring chiefly in the shallow waters of the northern hemisphere but extending southward in the eastern Atlantic to the Cape of Good Hope region. Two thirds of the species here recognized have been described in the past dozen years, during which period special attention has been given the Recent forms by Döderlein (1906) Mortensen (1907, 1913), and myself (1908). Mortensen in particular has given special attention to the pedicellariae, but these organs are of little use for either generic or specific distinctions. The globiferous and ophicephalous are usually wanting, but the ophicephalous are found not rarely on young specimens. Rostrate pedicellariae have not been found in the genus as yet. The number of primary tubercles on the dorsal side of the test, and the form, position, and composition of the subanal plastron, are the features which provide the best specific characters, but the form of the test and of the stout tridentate pedicellariae may be of use.

Key to the Species of Spatangus.

Primary tubercles of dorsal side numerous, 150 or more in all the interambulacra together.
- Subanal plastron more than twice as wide as high, with a re-entering angle on the upper side . . . . . *purpureus.*
- Subanal plastron not nearly twice as wide as high, with no re-entering angle.
  - Only 2 pairs of ambulacral pores (with large tube-feet) included within subanal fasciole on each side; petals II and IV tapering towards both ends, more or less decidedly so proximally.
    - Primary tubercles present in ambulacra between end of petal and ambitus . . . . . *raschi.*
    - Primary tubercles not present in ambulacra between end of petal and ambitus.
      - Subanal plastron more or less ventral in position its adoral margin only .75–.80 test-length from anterior end of test;[1] its length is about .18 test-length and its width about .25 (measured outside fasciole) . . . . . *capensis.*
      - Subanal plastron posterior, its adoral margin .85–.88 test-length from anterior end; its length is about .22 test-length and its width about .30 . . . . . *californicus.*
    - Three pairs of ambulacral pores (with big tube-feet) included within subanal fasciole on each side; petals II and IV broad, not tapering towards ends even proximally . . . . . *altus.*

Primary tubercles of dorsal side few, fewer than 50 in all the interambulacra together.
- Interambulacra 1 and 4 each with two, one or no primary tubercles.
  - Test about half as high as long; usually 1 or 2 primary tubercles in interambulacra 1 and 4; 9 or 10 primary tubercles in interambulacrum 5; subanal plastron very oblique, nearly ventral . . . . . *paucituberculatus.*
  - Test more than half as high as long; no primary tubercles in interambulacra 1 and 4; 1–9 primary tubercles in interambulacrum 5, subanal plastron more nearly vertical . . . . . *inermis.*
- Interambulacra 1 and 4 each with 6–12 primary tubercles.[2]
  - Sternum with little or no keel; subanal fasciole 1–1.5 mm. wide; color deep purple . . . . . *lütkeni.*
  - Sternum with conspicuous keel; subanal fasciole, 1.5–2 mm. wide; color grayish lavender . . . . . *pallidus.*

Spatangus purpureus.

O. F. Müller, 1776. Zool. Dan. Prod., p. 236.

This is a European species occurring from Norway to the Azores and in the Mediterranean Sea. Its bathymetrical range is 5–458 fms.

[1] Measured through one of the interambulacra 2 or 3 and not through the more or less depressed ambulacrum III.

[2] In my Key to the species of Spatangus (1908. Bull. M. C. Z., **51**, p. 308) the expression "lateral ambulacra" occurs twice, concerning *paucituberculatus*, *lütkeni*, and *pallidus*, where "lateral interambulacra" is intended. Such an error is most regrettable but will be remedied by the present key.

Spatangus raschi.

Lovén, 1869. Öfv. Vet. Akad. Förh. Stockholm, **26**, p. 733.

This species was long confused with the preceding as it too ranges from Norway to the Azores. It occurs in somewhat deeper water as a rule, the bathymetrical range being 100–805 fms. It is not known from the Mediterranean.

Spatangus capensis.

Döderlein, 1905. Zool. Anz., **28**, p. 624.

This species has been recorded from South African waters as *S. raschi* but seems to be constantly distinguishable. Its bathymetrical range is 40–280 fms.

Spatangus californicus, sp. nov.

Plates 146, fig. *20;* 149, fig. *4;* 156, figs. *1–3;* 157, fig. *10.*

The form of the test, as well as the size, of the holotype is shown in the figures (Pl. 156, figs. *2, 3;* 157, fig. *10*) but there is no little diversity shown in the series of specimens at hand. The largest specimen is 67 mm. long, 62 mm. wide and 34 mm. high, while another is 66 mm. long, 65 mm. wide and 32 mm. high. The lack of perfect bilateral symmetry which has been noticed in other members of the genus is to be seen in this species also. The apical system is subcentral and the petals radiate out from it at almost equal angles. The petals are long and narrow and taper very distinctly towards each end. The tuberculation of the test with its numerous primary tubercles is well shown in the figure (Pl. 156, fig. *3*). The periproct is wider than long and is close to the upper edge of the nearly vertical posterior end. The subanal plastron is large, its length in proportion to its width is considerable, and the surface is markedly convex; three ambulacral plates, with two large tube-feet, enter into its composition on each side (Pl. 149, fig. *4*). The position of the plastron is so nearly vertical that its most anterior (orad) point is 54 mm. from the anterior end of the test in interambulacrum 2, or .88 of test-length. The form of the peristome, labrum, and sternum, and the width of the bare, ventral ambulacra are all clearly shown in the photograph (Pl. 156, fig. *2*). The color of the bare test is dull purple above becoming gray on the sides and dirty yellowish beneath. The spines, however, which clothe the test densely, are, in preserved specimens, pale dingy brown, with no indication of purple.

The spines are for the most part 2 or 3 mm. long but on the sides of the petals are twice that length; the ventral primaries are very slender, about 10 mm. long, while the large dorsal primaries are a little stouter and if unbroken (seldom the case in these preserved specimens) are 15–20 mm. long. Pedicellariae are common but are all tridentate or triphyllous. The latter are relatively large with valves .15 mm. long. The slender tridentate have their valves .55–.95 mm. in length but are not at all distinctive. The stout tridentate, with valves .55–.70 mm. long, are more characteristic, for the outline of the blade (Pl. 146, fig. *20*) is markedly more elongated than in the related species, and strikingly different from the corresponding form in *S. capensis*, to which *californicus* seems to be most nearly allied.

The geographical isolation of this typical Spatangus is very striking. No species of the genus occurs in the West Indies and none is known from the Panamic region, nor from the American coast north of California. The nearest species geographically is at the Hawaiian Islands but there is no particularly close alliance morphologically with that species. Indeed the South African species seems to be, as stated above, the nearest member of the genus structurally, and were the specimens of *californicus* without locality labels, the bare tests would probably pass as young examples of *capensis*.

Station 2918. Off southern California. Bott. temp. 52.4°. 67 fms. Fne. gy. s.

Station 2 972. Off southern California. Bott. temp. 53.5°. 61 fms. Gn. m.

Station 2973. Off southern California. Bott. temp. 54°. 68 fms. Gn. m.

Station 2974. Off southern California. Bott. temp. 53.2°. 73 fms. Gn. m.

Station 2977. Off southern California. Bott. temp. 56.5°. 45 fms. Fne. gy. s., p.

Bathymetrical range, 45–73 fms. Extremes of temperature, 56.5°–52.4°. Twenty-five specimens.

Spatangus altus.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 131.

This species is as yet known only from a single specimen in the Copenhagen Museum, and supposed to be from the "China Seas." It seems to be a well-marked species, distinguished from all the other members of the genus by the composition of its subanal plastron.

Spatangus paucituberculatus.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 253.

Plates 146, fig. *19;* 157, figs. *7–9*.

Length 78 mm. or 73 mm. if the measurement is taken in the mid-line where ambulacrum III is so deeply depressed; width 74 mm.; height barely 40 mm. In nearly all the specimens the sternum is crushed in, preventing accurate measurement of the height, but there is no doubt that some were not half as high as long; some were almost or quite as wide as long. The form of the test, the tuberculation, the form of the petals, the position and shape of the subanal fasciole, the form and tuberculation of the sternum, and the narrow, curved, ventral ambulacra are all better understood from the photographs (Pl. 157, figs. *7–9*) than from any description. The apical system is markedly anterior and the four genital pores are very close together. Only three ambulacral plates, with two large tube-feet, enter into the composition of the subanal plastron on each side. The periproct is 9 mm. wide by 7 mm. high and is situated just below the upper margin of the posterior end of the test. Below the periproct the test slopes obliquely towards the mouth, but the convexity of the subanal plastron tends to obscure this obliquity. The peristome is very deeply sunken and so far overhung by the labium that it hardly shows in the photograph (Pl. 157, fig. *9*). The color is purple with white tubercles; primaries and secondaries silvery white becoming purple at base; miliary spines purple.

The covering of spines is rather dense; the miliaries are only about a millimeter long but most of the secondaries are 3 mm. and the smaller primaries 5–7 mm.; the largest primaries, in the posterior interambulacra are 12–15 mm. long. Pedicellariae are not very common and no globiferous, ophicephalous, or rostrate were found. The triphyllous pedicellariae have valves about .14 mm. long. The slender tridentate are not at all peculiar; the valves are 1.00–1.20 mm. long. The stout tridentate, with valves .45–.60 mm. in length, have the blade somewhat pointed, but the sides are convex and not straight, so the outline (Pl. 146, fig. *19*) is not triangular.

It is a remarkable fact that the nearest ally of this Hawaiian Spatangus is the recently described species, *inermis*, from the Mediterranean (see p. 238). It differs in the more flattened test, the more deeply sunken peristome, the presence of a few primaries in interambulacra 1 and 4, the more oblique subanal plastron and the shape of the valves of the stout tridentate pedicellariae.

These are trivial differences, but taken together they warrant keeping the species apart. The geographical isolation of the Hawaiian species is notable, but it seems more nearly related to the Japanese species, *lütkeni*, than to the geographically nearer *californicus*.

Station 3863. Off Mokuhooniki Islet, Pailolo Channel, Hawaiian Islands. Bott. temp. 60°–61°. 127–154 fms. Brk. co., crs. gr., r.

Station 3865. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 44.8°–45°. 256–283 fms. Fne. vol. s., r.

Station 4096. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 45.3°. 272–286 fms. Fne. gy. s.

Station 4097. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 44.2°. 286 fms. Fne. gy. s.

Station 4116. Off Kahuku Point, Oahu, H. I. Bott. temp. 48.8°. 241–282 fms. Co. s., for.

Bathymetrical range, 127–286 fms. Extremes of temperature, 61°–44.2°.

Twelve specimens, mostly crushed.

Spatangus inermis.

Mortensen, 1913. Mitt. Zool. Stat. Neapel, **21**, p. 24.

This recently recognized Mediterranean species is known as yet only from the Gulf of Naples, where it occurs at depths of 14–45 fms. on sandy and muddy bottoms.

Spatangus lütkeni.

A. Agassiz, 1872. Bull. M. C. Z., **3**, p. 57.

Plates 146, fig. *17*; 157, figs. *5*, *6*.

For purposes of comparison with nearly related forms, it has seemed desirable to give some figures of this species. The side and rear views (Pl. 157, figs. *5*, *6*) of a small specimen are shown for comparison with similar views of the following species. Attention may be called to the short vertical diameter, the flatness of the sternum, and the slight prominence of the subanal plastron.

Pedicellariae are abundant but are nearly all tridentate. A few triphyllous, with valves about .12 mm. long, were found, but no globiferous, ophicephalous, or rostrate were seen. The slender tridentate show a remarkable diversity

in size, the valves being .25–1.35 mm. long, but have no distinctive character. The stout tridentate on the other hand show much less diversity in size, with valves only .45–.70 mm. long, but are quite characteristic. The outline of the blade (Pl. 146, fig. 17) is rounded triangular, while the base is remarkably broad. A typical pedicellaria of this kind from the type specimen of *lütkeni* gave the following measurements for each valve: length, .68 mm.; width of basal part, .55 mm.; height of base, .38 mm.; length of expanded part of blade, .18 mm.; width of same, .23 mm.

This species has been recorded from the Moluccas by Sluiter, but the Siboga failed to find it in the East Indies, and it is not otherwise known save from Japan.

Station 3771. Off Doumiki Saki, Honshu Island, Japan. Bott. temp.? 61 fms. Gn. m., s.

Station 4807. Off Cape Tsiuka, Japan. Bott. temp.? 44–47 fms. Sh., crs. g.

Station 5047. Off Kinka San Light, Japan. Bott. temp. 49.6°. 107 fms. Dk. gy. s., brk. sh., p.

Bathymetrical range, 44–107 fms.

Six specimens.

Spatangus pallidus.

H. L. Clark, 1908. Bull. M. C. Z., **51**, p. 307.

Plates 146, fig. *18*; 149, fig. *5*; 157, figs. *1–4*.

All of the specimens I have seen of this species are small and probably young and it is not impossible that they are merely a form of *lütkeni*, but the markedly lighter color and the strongly keeled sternum give them quite a different appearance. The photographs of the holotype (Pl. 157, figs. *1–4*) show well the characteristic form of the test, subanal plastron, and sternum. The two latter features are even better shown in the drawing (Pl. 149, fig. *5*) where the composition of the plastron is clear. The great width of the subanal fasciole is also well brought out in this figure.

Pedicellariae seem to be very infrequent. Examination of two specimens revealed only a single triphyllous with valves about .11 mm. long, some slender tridentate, with valves .30–.80 mm. long but not distinctive, and a single stout tridentate, with valves about .60 mm. long, and .35 mm. wide basally. The

outline of the blade (Pl. 146, fig. *18*) is nearly circular as the tip is not at all pointed; its length, however, exceeds its width.

The original specimens of this species were from Sagami Bay, Japan. The present collection contains a single specimen from

Station 3713. Off Ose Zaki, Honshu Island, Japan. Bott. temp.? 45–48 fms. Vol. s., sh., r.

Gonimaretia, gen. nov.[1]

Type, *Gonimaretia tylota*, sp. nov.

As long ago as 1883, de Loriol (Mem. Soc. Phys. Hist. Nat. Genève, **28**, no. 8, p. 50) called attention to the remarkable discrepancy between the description of *Maretia alta* A. Ag. in the Revision and the figures, labeled with that name, in the CHALLENGER Report. De Meijere (1904) and Koehler (1914) having referred to the same difficulty, I recently explained it (1914, Spol. Zeylanica, **10**, p. 91), pointing out that the specimen figured in the CHALLENGER Report is not *alta* but quite a distinct species. This specimen and others were taken near the Kei Islands and several are in the M. C. Z. collection; while not so large as the figured specimen, they agree with it in most particulars. The well-developed sternum and the presence of only 3 genital pores made the reference of these specimens to Maretia doubtful, and the discovery in the ALBATROSS collection of a closely allied species from the eastern Pacific, necessitated the institution of a new genus for them. The fact that Studer's *Lonchophorus interruptus* is apparently congeneric with them required consideration of the question as to whether the group should not be called Lonchophorus. This name originated with Studer (1880), in a generic sense, as a correction for Conchophorus Laube, which Studer considered a *lapsus calami*. The two names are absolute synonyms and if either is used Conchophorus should have precedence: but Laube's group is quite indistinguishable from Spatangus and hence Conchophorus is a synonym of Spatangus. The present genus, Gonimaretia, is, however, quite different from Spatangus and cannot be confused therewith. The fact that ambulacrum III is not at all depressed, added to the characters given in the key (p. 199), distinguishes Gonimaretia. The pedicellariae, so far as known, fail to furnish any additional points of difference, though they are not just like those of Spatangus.

[1] Γωνία = angle + Maretia, the name of an allied genus; in allusion to the sharp angle formed by the poriferous areas in petals II and IV.

Key to the Species of Gonimaretia.

Test wide and flat, the width nearly .90 length, the height much less than .45 length; 3 large primary tubercles in each of interambulacra 1 and 4, near ambitus . . . . . *tylota.*

Test narrower and higher, width .80–.85 length and height about half length; no primary tubercles on dorsal surface.

Petals I and V much wider proximally than distally; posterior end of test vertically truncate, not overhanging . . . . . *laevis.*

Petals I and V of nearly uniform width; posterior end of test obliquely truncate and overhanging . . . . . *interrupta.*

Gonimaretia tylota, sp. nov.[1]

The only available specimens of this species are from the CHALLENGER collection. The one selected for the holotype (M. C. Z. Cat. no. 3208) is 31 mm. long, 27 mm. wide and not quite 14 mm. high. A slightly larger specimen is relatively wider and flatter, 33 mm. long, 30 mm. wide and 14.5 mm. high. The figures in the CHALLENGER Report (Pl. 37, figs. *1–4*) give a good idea of the appearance of the specimen with spines on (fig. 1) and of the general appearance of the bare test. But the figures are all enlarged about twenty per cent and the relative proportions are not perfectly exact. The petals are not very successfully reproduced. Petals I and V are in their general form like petal V in fig. *6*, Pl. 161, but are decidedly narrower; they are about 12 mm. long, 3 mm. wide proximally and almost pointed distally; in the outer series of pore-pairs, there are 22 or 23 of which the basal 5 or 6 are extremely small and can hardly be made out; in the inner series, there are 21 pore-pairs of which the basal 7 can hardly be made out. Petals II and IV are even more different from the CHALLENGER figure. They are notably unequal and this asymmetry is shown in all four of the specimens before me. Petal II is about 9 mm. long (in the holotype) and has 14 pore-pairs in the posterior series, all but the basal two being large and easily seen; in the anterior series are approximately the same number of pore-pairs, but only the 4 or 5 at the tip of the petal are visible and these diverge from the posterior series at an angle of about 40°. Petal IV is about 11 mm. long and there are 17 pore-pairs of which 15 are conspicuous. The apical system is very compact and there are large genital pores in genital plates 1, 3, and 4; there is no pore in 2. Ambulacrum III is not at all petaloid and is not sunken in the least; the pores are small and the plates are not easily distinguished. Just anterior to the apical system on each side of ambulacrum

[1] Τυλωτός = knobbed; in allusion to the knob-like primary tubercles on each side.

III is a cluster of 10–15 large secondary or small primary tubercles, but these are not conspicuous. They are visible in fig. 2 of the CHALLENGER Report.

The periproct is slightly sunken, especially its lower portion. The posterior end of the test is vertical or slightly oblique outwardly in its upper half, but the lower half is markedly oblique towards the mouth. The upper margin of the periproct and the upper margin of the end of the test coincide, but the lower margin of the periproct is nearly or quite a millimeter below the sides of the test-end. The subanal plastron is rounded-triangular rather convex, and includes on each side four ambulacral plates, with three large tube-feet. The point where the subanal fasciole crosses the end of the sternum is very conspicuous, the subanal plastron, ambulacra I and V and the sternum all sloping to it. This is well shown in fig. 4 of the CHALLENGER Report. The sternum is fairly well developed, about 11 mm. long and 5 mm. wide at posterior end; except the extreme anterior end it is well covered by primary tubercles. The labrum is about 4 mm. long and, at the middle about 1.70 mm. wide; it is markedly T-shaped. All the features of the oral surface of the test are fairly well shown in fig. 3 of the CHALLENGER Report, but it should be stated that the posterior end of the labrum does not reach back to the end of the second ambulacral plate on each side. The color of these specimens is hard to name. Mr. Agassiz calls it "dark pinkish buff." After their long sojourn in alcohol, they are very light brown, but still with a decidedly pinkish cast. The primary spines are white or nearly so.

The covering of miliary and secondary spines is fairly uniform, but they are longer at the apical system and at the posterior end of the test than elsewhere. The abactinal primary spines are all broken, but those of the oral surface are 5 or 6 mm. long; those along the sides of the sternum are longest and are markedly curved. Pedicellariae are abundant orally and at the posterior end of the test. The most striking are those occurring on the bare ventral ambulacra, and which I call globiferous. (Similar pedicellariae in Pseudomaretia and Lovenia are considered a form of tridentate by Döderlein and Koehler. Döderlein at first called them "globiferous" but later, on finding another sort of globiferous in *Lovenia subcarinata*, called them "bandförmige" tridentate. It seems desirable to call them globiferous because of the conspicuous glandular tissue which surrounds the tips of the valves). These pedicellariae have stalks about half a millimeter long, the lower part of which is slender but the distal half is conspicuously swollen; a constriction around the swelling makes it possible to distinguish between a coarser, lower swelling and a finer, more compact

terminal one. The valves of these pedicellariae are for the most part widely open, in the preserved specimens, lying about horizontal with reference to the vertical stalk. They are .40–.50 mm. long, very flat and narrow and terminate in two sharp, slightly diverging teeth; the general appearance is much like the valves in *Lovenia elongata* as figured by Koehler (1914. Ech. Indian Mus. Spat., pl. 19, fig. 26). The stalks and most of each valve in these curious pedicellariae are cream-color or nearly white, but the tip of each valve is encased in deep purplish or bluish black glandular tissue giving the open pedicellaria an odd appearance.

Besides these globiferous pedicellariae, ophicephalous, tridentate, rostrate, and triphyllous also occur. The triphyllous are quite common but are very small; the valves are only about .07 mm. long, and the blade is less than .05 mm. wide. The ophicephalous are rather rare, and notable for remarkably long and narrow valves, which are about .20 mm. long, with the blade narrowly oval, about .06–.07 mm. wide and the base .10 mm. across. The tridentate and rostrate seem to intergrade and it might be better to call them all tridentate. But I have reserved the name rostrate for the small form, with valves .15–.30 mm. long, distinctly curved and meeting only at tip, and with a rather wide blade which is not noticeably compressed. The tridentate proper are of two kinds, the stout and the slender. The stout have the valves .40–.80 mm. long and the blade one eighth to one fifth as much in width; the blade is strongly compressed especially near base so that its depth is nearly equal to its width. The slender tridentate have the valves .45–.75 mm. long; the blade, however, is exceedingly narrow, its width, even near tip, where widest, only one fourteenth to one tenth as great as its length, while its depth may actually exceed its width; in a valve not quite .75 mm. long, the base is .10 mm. wide, the blade .10–.15 mm. from tip is .05–.06 mm. wide and about .04 mm. deep, while at its base the blade is only .02 mm. wide but is .06 mm. deep. The margins of the blade in both kinds of tridentate pedicellariae are finely but conspicuously serrate. It is chiefly on and about the periproct, and on the subanal plastron that tridentate pedicellariae occur.

This interesting species is undoubtedly near to *Pseudomaretia alta* in many ways, but the character of the periproct as well as that of the sternum prevents placing it in the same genus. The important difference between the sterna of Gonimaretia and the nearly allied genus Lovenia is well brought out by comparing the figures, Pl. 161, fig. *5* and Pl. 160, fig. *7*. There is no doubt that Gonimaretia, Lovenia, Pseudomaretia, Pseudolovenia, and Maretia constitute

a group of closely related forms, whose extremes are very different from Spatangus yet with which genus they are apparently rather clearly connected.

The CHALLENGER took *Gonimaretia tylota* at her stations 191 and 192, near the Kei Islands in 129–800 fms. on muddy bottoms. So far as I know, it has not been met with since.

Gonimaretia laevis, sp. nov.

Plates 149, figs. *1–3*; 161, figs. *5–7*.

Length 24–32 mm.; width 20–27 mm.; height, 12–16 mm. The largest specimen is relatively a trifle wider than the others, but the difference is very slight. The outline of the test is slightly ovoid (Pl. 161, figs. *5*, *6*); it is highest just back of the middle and slopes more anteriorly than towards the back (Pl. 161, fig. *7*). The apical system is slightly anterior and very compact, with three large genital pores (Pl. 149, fig. *1*; 161, fig. *6*). The characteristic form of the petals with the arrangement of the pore-pairs is well shown in the photograph (Pl. 161, fig. *6*). The asymmetry between petals II and IV is indicated but it is not quite so marked as in the preceding species, although more abundant material might emphasize it. In the largest specimen (Pl. 161, fig. *6*) there are 13 large pore-pairs in the posterior series of petal II while there are 15 in the same series of petal IV; in the anterior series there are 5 pairs in petal II but only 4 in petal IV; the anterior series forms an angle of about 45° with the posterior series at the tip of the petal. The completion of the petals seems to occur late in growth for in neither of the two smaller specimens is there any anterior series of large pore-pairs; in one specimen there is one such pair just indicated at the tip of the petal, and in the other, two pairs can be distinguished as larger than the others. In the posterior petals, the three specimens are nearly alike with 11 or 12 pore-pairs in the inner series and 13 or 14 in the outer.

The posterior end of the test is truncate with the periproct near its upper margin (Pl. 149, fig. *2*). The periproct is wider than high and even its lower margin is very little depressed. The subanal fasciole is very distinct and the enclosed plastron is slightly convex; there are 4 ambulacral plates with 3 large tube-feet included on each side; the upper half of the plastron is nearly vertical but the lower slopes rather markedly towards the mouth. The bare ventral ambulacra and the long, narrow, sternum fully covered with tubercles is well shown in the photograph (Pl. 161, fig. *5*) but the peristome and labrum appear more clearly in the drawing (Pl. 149, fig. *3*). It is worthy of note that the

length of the labrum increases with age; the drawing was made from the smallest specimen; in the next larger specimen the labrum reaches well below the middle of the second pair of ambulacral plates and its length is about 4 mm. with a width at middle of less than 2; in the largest specimen, the labrum is nearly 5 mm. long but its width is still less than 2. The color of test and spines in all the specimens is very pale brown or a brownish white.

The covering of spines is largely rubbed off in the material at hand and the remaining primaries are all broken. Apparently the spines, both in size and arrangement, are much as in *G. tylota*. Pedicellariae are scarce on these specimens. The triphyllous with valves nearly .10 mm. long and .06 mm. wide seem to be a little more elongated than those of *tylota*. No globiferous or ophicephalous pedicellariae were found and the tridentate are all of one kind; these may perhaps be called rostrate, as they are not at all like the tridentate of *tylota*, and no other rostrate were seen. The valves are .40–.65 mm. long; their form is intermediate between the tridentate of Homolampas (see Pl. 146, fig. *2*) and the rostrate of Brissus (see Mortensen, 1913. Mitt. Zool. Stat. Neapel, 21, pl. 4, fig. 22); the blade is .09 mm. wide at base and .13 mm. wide near tip in the largest examples, while the base is about .25 mm. in height and in width too.

This species is certainly very near *tylota* but aside from the lack of primary spines dorsally, the much larger petals will serve as a distinguishing feature. The test of *laevis* is not so high posteriorly and the subanal plastron is not so prominent; the sternum too is not quite so keeled and the conspicuous point at its posterior end is lower. It is a matter of considerable interest to find this nearest relative of a Kei Islands species, on the Californian coast, and the interest is enhanced by the fact that Lovenia, an allied East Indian genus, also has a well-marked representative in western American waters.

Station 2911. South of San Clemente Island, California. Bott. temp. about 53°(?) 60 fms. R., s.

Gonimaretia interrupta.

Lonchophorus interruptus Studer, 1880. Monatsb. Berlin Akad. Wiss., p. 880.

It is a great pity that our knowledge of this species is not more complete. The unique holotype was taken in 30 fms. on the west coast of Australia, but Studer gives no more exact locality. Mortensen has examined the specimen

in Berlin and states that it is certainly not a Spatangus, but he does not commit himself as to the genus to which it does belong. I am placing it in Gonimaretia on the strength of Studer's figures.

Maretia.

Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 48.

Type, *Spatangus planulatus* Lamarck = *Spatangus ovatus* Leske, 1778. Add. ad Klein, p. 188.

Aside from the type species, which seems to be common, the members of this genus are little known, three of the other four species, being based on unique specimens. The appearance of the ventral surface is very characteristic for only Lovenia and Pseudolovenia can rival Maretia in the smallness of the tuberculated part of the sternum, and those genera are easily distinguished by the characters of the dorsal surface. Young individuals of Gymnopatagus in which the peripetalous fasciole is very slightly developed may be mistaken for Maretia, unless attention is directed to the labrum and sternum. The pedicellariae of Maretia are not at all distinctive, so far as they are known; globiferous have been found only in one species and ophicephalous in three, and there is no sharp line between the rostrate and the tridentate in any species.

Key to the Species of Maretia.

Height of test less than half its length.
- Test-width more than .75 of length; width of bare ventral area .40 of test-width or more.
  - No large primary tubercles in interambulacrum 5 dorsally.
    - 3 or 4 very large and deeply sunken primary tubercles in each of interambulacra 1, 2, 3 and 4 dorsally . . . . . *tuberculata.*
    - Primary tubercles in interambulacra 1, 2, 3 and 4 dorsally more numerous and much less conspicuous . . . . . *ovata.*
  - Many large primary tubercles in interambulacrum 5 dorsally . . . . . *peloria.*
- Test-width scarcely .70 of length; width of bare ventral area about .33 of test-width; test nearly uniformly covered with primary tubercles, no distinctly larger ones on dorsal surface . . . . . *elliptica.*

Height of test more than half its length . . . . . *elevata.*

Maretia tuberculata.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **51**, p. 134.

Plate 160, figs. *5–7.*

Length 26 mm.; width, 22 mm.; height 12 mm. The form of the test, the tuberculation, and the extensively bare lower surface are all brought out well

in the photographs (Pl. 160, figs. *5–7*). The petals are narrow and the pore-pairs are small, so these points do not show well in the figures. Petals I and V are about 9 mm. long and have 17–19 pore-pairs in each series of which the basal 5 or 6 can scarcely be detected with a lens; these petals are only 2 mm. wide and the interporiferous area is greatly reduced; the tip of the petal is quite pointed. Petals II and IV are only 6 mm. long and 1.5 mm. wide; the pore-pairs of the basal half dozen plates cannot be made out but there are 9 evident pore-pairs in the posterior series and 6 slightly smaller ones in the anterior series. Ambulacrum III is flush with the adjoining interambulacra and is not differentiated in any way, save that there is on each side a series of small primary tubercles. The apical system is very compact and there are no genital pores. The posterior end of the test is vertical with the small nearly circular periproct near its upper margin. The subanal fasciole is narrow but distinct and encloses a very complex subanal plastron, nearly vertical in position and markedly convex; on each side are included no fewer than 7 ambulacral plates of which the lowest (the sixth from the peristome) is much the largest and the two uppermost are smallest and barely come within the fasciole; all but the lowest and uppermost are accompanied by large tube-feet so that there are 5 of these on each side; the entire plastron is about 9 mm. wide by 4 mm. high. The sternum is about 8 mm. long but only the posterior three eighths is occupied by tubercles. The labrum is nearly 5 mm. long by 1 mm. wide and reaches almost to the third ambulacral plate on each side. The peristome is about 4 mm. wide by 2.5 mm. long and is scarcely sunken at all. The specimen was fairly well covered with spines and the general color was very light purplish gray, which with the passage of time has become a very light brown; the larger spines are nearly white.

The miliary spines are minute and slightly thickened at the tip while the secondaries are conspicuously larger and are more or less curved; on the lower, posterior parts of the test, they pass into the ventral primaries which are 8 mm. long, at the longest. The large dorsal primaries are 10–12 mm. long and are slightly curved. Pedicellariae are not abundant, but three kinds were found. The ophicephalous are common on the ventral ambulacra; the valves are only .14–.16 mm. long besides a loop of .06–.09 mm., and there is nothing characteristic in their form. The rostrate or coarse tridentate are not common; they are similar to those of *Gonimaretia laevis* but the valves are rather more pointed; they measure .27–.43 mm. in length. The triphyllous are also uncommon and the valves scarcely exceed .10 mm. in length.

The absence of genital pores and the appearance of the petals show at once that this is a young individual. The large primary tubercles of the dorsal

surface are very much like those of Lovenia but the entire absence of any fascioles on the dorsal surface shows that the relationships are clearly with Maretia, as the form of the test indicates. The composition of the subanal plastron is very different from that of *ovata*, where it is made up of 3 (4?) ambulacral plates on each side, with 2 (3?) large tube-feet, but in this important feature *tuberculata* is surprisingly near to *peloria* (p. 249). We know nothing about the composition of the plastron in either *elliptica* or *elevata*. The occurrence of a Maretia in Korea Strait is interesting for while *M. ovata* is known from Sagami Bay, it is not recorded from the western coasts of Japan and the genus is essentially tropical.

Station 4875. Korea Strait, west of Shimonoseki, Japan. Bott. temp. about 60°. 59 fms. Fne. gy. s., brk. sh.

Maretia ovata.

Spatangus ovatus Leske, 1778. Add. ad Klein, p. 188.
Maretia ovata Hamann, 1904. Bronn's Thier-reich, **2**, abt. 3, p. 1397.

Presumably because Leske's *Spatangus ovatus* was not identical with Klein's *Scutum ovatum*, Mr. Agassiz retained in the Revision Lamarck's specific name, *planulata*, for this spatangoid. But since Klein's names have only a historical interest, and since Leske's name is the first post-Linnaean name for this species, there is no reason for using any other than that name. The species ranges from Reunion and Mauritius to the Gilbert Islands, (I find no records for either the Hawaiian or the Society Islands), north to Japan (Sagami Bay), and south to Port Jackson, N. S. W. Koehler (1914. Ech. Indian Mus. Spat.) has given a very full account of the pedicellariae, with which my own observations accord; the absence of ophicephalous pedicellariae, as well as of globiferous, deserves special note. The Albatross collection contains five specimens and some fragments from the Marshall Islands (a small one is labeled "Wotje") and from Taritari, Gilbert Islands. All were taken in January, 1900.

Maretia peloria.

H. L. Clark, 1916. Zool. Res. Endeavour, **4**, p. 121.

Plate 146, fig. *25*.

In my published account of this species from the southern side of Australia, the pedicellariae are fully described but not figured. I give here a figure of one valve (Pl. 146, fig. *25*) of the remarkable globiferous pedicellariae. No details

in regard to the composition of the subanal plastron were given at the time the description was written as the importance of this point was not realized. Re-examination of a paratype shows that the plastron is very different from that of *M. ovata* and very similar to that of *M. tuberculata*. Seven ambulacral plates on each side enter the plastron but the uppermost (the seventh) barely extends its lower, inner corner within the fasciole, and there are only five large tube-feet on each side.

Maretia elliptica.

Bolau, 1874. Arch. f. Naturg., 40, **1**, p. 175.

The unique holotype of this species is from Malden Island, Tropical Pacific Ocean. It is rather remarkable that the species has not been found elsewhere.

Maretia elevata.

Döderlein, 1906. Valdivia Ech., p. 263.

This species is also known from only a single specimen, which was taken off Witu Land, British East Africa. The most remarkable point, however, is that this specimen was taken at a depth of 385 fms., an unprecedented depth for a Maretia. The individual was only 30.5 mm. long but the genital pores were fully developed.

Pseudomaretia.

Koehler, 1914. Ech. Indian Mus. Spat., p. 107.

Type, *Maretia alta* A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 360.

Plate 146, fig. *24*.

As Koehler (*op. cit.*) and I (1915. Spolia Zeylanica, **10**, p. 91) have recently discussed the type species of this monotypic genus, and as it had already been described and well figured by de Loriol (1883. Mem. Soc. Phys. Hist. Nat. Genève, **28**, no. 8, p. 49–51), there is no occasion to go into details here. I have, however, thought it of interest to figure one of the remarkable pedicellariae of the ventral ambulacra (Pl. 146, fig. *24*) as Koehler figures the valves separately and a stalk which is somewhat different from those I have seen. As already explained the figures in the Challenger Report, on plate 37, supposed to be of this species, are in reality of *Gonimaretia tylota* (p. 241). From Mauritius, the range of *Pseudomaretia alta* extends via Ceylon, where it seems to be common, to the East Indies, Formosa, and southern Japan.

Breynia.

Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), **8**, p. 12.

Type, *Spatangus crux-andreae* Lamarck, 1816 = *Spatangus australasiae* Leach, 1815. Zool. Misc., **2**, p. 68.

This highly specialized genus was long monotypic and supposed to be characteristic of Australia, so that Anderson's rather recent discovery of a second species at the Andaman Islands is a matter of great interest. The presence of a peripetalous, as well as an internal fasciole, makes the genus easy to recognize.

Key to the Species of Breynia.

Apical system about .45 test-length from anterior end; area within peripetalous fasciole about .80 test-length; numerous large primary tubercles within peripetalous fasciole, except in interambulacrum 5 . . . . . *australasiae.*

Apical system only about .33 test-length from anterior end; area within peripetalous fasciole about .65 test-length; large primary tubercles less numerous . . . . . *vredenburgi.*

Breynia australasiae.

Spatangus australasiae Leach, 1815. Zool. Misc., **2**, p. 68.
Breynia australasiae Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 46.

Plate 146, fig. *31*.

This fine spatangoid is common in Torres Strait and extends southward on the western coast of Australia at least as far as Fremantle and on the eastern coast to Lord Howe Island and Port Jackson. The records from the Red Sea and Hawaiian Islands are incredible and those from Hong Kong and Japan probably rest on misplaced labels; mistaken identifications are unlikely in this case.

The pedicellariae are abundant and varied; though characteristic they are in no way remarkable. No globiferous pedicellariae were found. The ophicephalous are very common and are quite distinctive; the valves (Pl. 146, fig. *31*) are shorter and wider than in most spatangoids; they measure about .22 mm. long with the loops .06–.09 mm. more. The rostrate are also quite common and reach a very large size; the valves range from .38 to 1.55 mm. in length; in the largest the base is nearly .70 mm. high and about .65 mm. wide, while the blade is .85 mm. long, and about .15 mm. wide at both base and tip. Tridentate pedicellariae are rare but there are two kinds; stout ones with the

valves .60 mm. long, the base. 25 mm. wide and about the same in height, and the rather flat blade more than .15 mm. at the middle where it is widest; and slender ones with the valves .30–1.00 mm. long and the blade very narrow; in a valve .95 mm. long, the base is more than .25 mm. high but is less than .20 mm. wide, while the blade, about .70 mm. long and only .06 mm. wide, is much compressed (about .06 mm. deep) and has finely serrate margins; the apophysis is very conspicuous, some .20 mm. deep. Triphyllous pedicellariae are apparently rare; the valves are distinctly longer than wide but only measure .10 mm. in length.

Breynia vredenburgi.

Anderson, 1907. Journ. and Proc. Asiatic Soc. Bengal, (2), **3**, p. 145.

So far as the limited material admits of an opinion, this seems to be a well-marked species, which is as yet known only from Port Blair, Andaman Islands. The shape, as well as the dorsal tuberculation of the test, is very different from that of any example of *B. australasiae* which I have seen.

Lovenia.

Agassiz and Desor, 1847. Ann. Sci. Nat. Zool., (3), **8**, p. 11.

Type, *Lovenia hystrix* Agassiz and Desor, 1847 = *Spatangus elongatus* Gray, 1845. Eyre Voy. **1**, p. 436.

This is a genus of notable spatangoids of moderate or large size, with long and very conspicuous dorsal primary spines. These spines are placed on tubercles which are so deeply sunken in the test that they give rise to more or less overlapping, swollen rings on the interior surface of the test. Such internal swellings are indicated in large specimens of Homolampas, as well as in Maretia and some other genera, but in no genus (except Pseudolovenia) are they so striking as in Lovenia. The possibility of a relationship between Homolampas and Lovenia must not be overlooked and there can be little doubt that they are more nearly related than the classification here used would seem to indicate. The pedicellariae in Lovenia are abundant and very diversified; ophicephalous have only been found in one species, and the same is true of one form of globiferous, but all other forms are of general occurrence. The most characteristic form is that called globiferous (p. 242) and which is known also in Maretia, Gonimaretia, and Pseudomaretia. These occur only on the bare ventral ambulacra and in dry specimens are so easily knocked off that they often seem to be

wanting. Another characteristic pedicellaria in Lovenia may be called *multidentate, i. e.* tridentate pedicellariae with more than three valves; there may be 4 valves in which case the separate valves are much like those of the true tridentate; but when there are 5, 6, 7 or even 8 valves as is often the case, the valves assume a different and characteristic form with a compressed base and sometimes with a modified blade. Often these pedicellariae have a long neck but this is not always the case. Mortensen has found a somewhat similar pedicellaria in Brissopsis, probably a case of "parallelism" as the genera are probably not very nearly allied. Neither Koehler nor Döderlein seem to have met with these multidentate pedicellariae, but Döderlein describes and figures a form of tridentate, having base and blade of equal length and the blade imperforate, which I have not found.

Key to the Species of Lovenia.

Genital pores 4.
- Periproctal region markedly sunken into posterior end of test.
  - Test broad and flat, its width exceeding .75 of its length.
    - Test highest at, or anterior to, apical system; 6–10 large pores-pairs on each side of subanal plastron . . . . . *elongata.*
    - Test highest in the somewhat carinate interambulacrum 5 back of apical system; only 4 or 5 large pore pairs on each side of subanal plastron . *camarota.*
  - Test narrower and higher, its width about .75 of length or less . . . . . *cordiformis.*
- Periproctal region little or not at all sunken.
  - Test narrow, width .75 of length or less; large dorsal primary tubercles few . . *subcarinata.*
  - Test wide and flattened, width .80 length or more; large dorsal primary tubercles numerous.
    - Test not heart-shaped, its width .80–.85 length . . . . . *gregalis.*
    - Test heart-shaped, its width .90 length or more . . . . . *grisea.*

Genital pores 3 . . . . . *triforis.*

Lovenia elongata.

Spatangus elongatus Gray, 1845. Eyre Voy., **1**, p. 436.
Lovenia elongata Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 131.

This species ranges from Zanzibar and the Red Sea to northern Australia and Japan. The pedicellariae have been described and figured by both Koehler and Döderlein. I am unable to account for Mr. Agassiz's statement that this species was collected in the Gulf of California by W. J. Fisher as shown by specimens in the M. C. Z. Collection. All the Lovenias collected by Fisher and now in the M. C. Z. collection are *cordiformis.*

Lovenia camarota, sp. nov.[1]

Plate 161, figs. *1–4*.

Length 53 mm.; width at apical system, where widest, 42 mm.; height at apical system, 18.5 mm.; height back of apical system, where highest, 22.5 mm. The form of the test, its tuberculation, the appearance of the petals, and the slight depression of ambulacrum III are clearly shown in fig. *1*; the keel-like elevation of interambulacrum 5 and the slight prominence of the subanal plastron are shown in fig. *2*; the very bare actinal surface, the nearly flush peristome and the deeply sunken periproct are evident in fig. *3*; while the inter-ambulacral keel and the position of the periproct is brought out in fig. *4*. The internal fasciole and the 4 genital pores are very distinct in the specimen, but do not show well in the figure. The periproctal depression is nearly circular, 12 mm. across, but the periproct which is on its upper side is only 5 mm. high by 6 mm. across. The subanal fasciole is distinct and the plastron it bounds is 20 mm. wide, 9 mm. high at each end and only 4.5 mm. high in the middle. On each side of the plastron are about 15 large primary tubercles more or less deeply sunken in the test; on the right side 6 ambulacral plates enter the plastron with 5 pairs of pores but on the left side only 5 ambulacral plates enter the plastron and there are only 4 large pore-pairs. The labrum is 10 mm. long and about 3 mm. wide where widest; it adjoins just two ambulacral plates on each side but the second one is notably prolonged to reach the tip of the labrum. The primary spines are all broken or missing and most of the secondary and miliary spines are rubbed off. The color of the test is light gray with more or less of a brownish tinge especially where any spines are left; ventrally and posteriorly where rubbed the test is nearly white.

In spite of the condition of the specimen, two kinds of pedicellariae were found, rostrate and tridentate. The former have valves so strongly curved that measured on the arc they are about .45–.55 mm. long but measured on the chord they are only .38–.45 mm.; the blade is very narrow, not enlarged but finely toothed at the tip. The tridentate have valves .30–.35 mm. long, narrow, compressed, and straight; the margins were cut with squarish notches giving a very unusual, somewhat unfinished appearance, but as there was only

[1] Καμαρωτὸς = arched; in allusion to the highly arched interambulacrum 5.

a single pedicellaria of this sort this blunt, marginal serration may have been simply a peculiarity of that one.

This well-marked species is based on a single specimen in the M. C. Z. collection (No. 3201) which was taken by the CHALLENGER at her station 188, west of Torres Strait, 28 fms., mud. It was labeled *Lovenia elongata*, but whether the other specimens listed in the CHALLENGER Report are conspecific with this specimen or not there is no means at present of knowing. The differences in the form of the test are very striking but the difference in the subanal plastron is probably more important.

Lovenia cordiformis.

A. Agassiz, 1872. Bull. M. C. Z., **3**, p. 57.

Plate 161, figs. *8–12*.

Although this species is near enough to *elongata* to make confusion of the two possible, the narrower and higher test of *cordiformis* distinguish it easily, as a rule, when specimens are compared side by side. But it is possible that there are specimens of *elongata*, relatively high and broad, which cannot be separated in this way, from the lower and flatter specimens of *cordiformis*. Of course very young specimens (Pl. 161, figs. *10–12*) can scarcely be distinguished by the shape of the test. The pedicellariae, however, offer some points of difference which probably hold for all ages. The characteristic globiferous pedicellariae on the ventral ambulacra have the valves about .30 mm. long in *elongata* and the stalk about the same; in *cordiformis*, the valves are .45–.55 mm. long and the stalks about .75; the latter are uniformly fusiform in *cordiformis* but in *elongata* are abruptly tapered at each end. The rostrate pedicellariae are very common in *cordiformis* and have the valves, .40–.50 mm. long, not greatly curved but rather abruptly so at the tip; the blade is about half the valve; it is distinctly widened at the tip but even at the middle, its width is one sixth to one fifth of its length; in *elongata* the blade may be much more than half the length of the valve and its width may be not more than one ninth of its own length. The triphyllous and tridentate show no differences of importance. In *cordiformis*, the triphyllous valves are about .12–.15 mm. long and .05–.06 mm. wide; the tridentate are .17–.82 mm. long with the blade rather more than half of that; the width of the blade, which in large pedicellariae is more or less compressed, is about one third of its length or somewhat less. The most conspicuous pedicellariae in *cordiformis* are the multidentate. These have

not been found in *elongata* by either Döderlein or Koehler. The number of valves ranges from 4 to 8 and they range in length from .60 to 1.25 mm.; these pedicellariae often have a neck longer than the valves but as this appears to be very contractile, many examples seem to have no neck at all. When there are only four valves they differ little in form from those of the normal tridentate pedicellariae but when there are seven or eight, the base becomes compressed and elongated and markedly gibbous at the bottom, while the blade has a conspicuous constriction where it joins the base; the blade is widest just distal to this constriction and tapers thence very gradually to a pointed tip, which is bent inward more or less noticeably; the blades are sometimes distinctly curved but except for the tip are generally nearly straight. These pedicellariae occur about the peristome and along the sides of the ventral ambulacra.

This Lovenia occurs along the western coast of tropical and subtropical America from San Diego to Guayaquil. The following are the places where the ALBATROSS collected it; nearly all the specimens are bare tests and quite small. Of one of these the three photographic figures (Pl. 161, figs. *10–12*) show the sutures beautifully.

Station 2796. Gulf of Panama. Bott. temp. about 64°. 33 fms. Gy. s., brk. sh.

Station 2813. Southwest of Chatham Island, Galapagos. Bott. temp.? 40 fms. Co. s.

Station 2822. Near La Paz, Lower California. Bott. temp.? 21 fms. Gy. s., brk. sh.

Station 2823. Near La Paz, Lower California. Bott. temp.? 26.5 fms. Brk. sh.

Station 2826. Off Ceralbo Island, Lower California. Bott. temp.? 9.5 fms. Sh.

Station 2827. Off Ceralbo Island, Lower California. Bott. temp.? 10 fms. Sh.

Station 2964. Near Santa Barbara, California. Bott. temp.? 21.5 fms. S., st.

Station 2994. Near Revillagigedo Islands. Bott. temp. 66.6°. 54 fms. Brk. co.

Station 3012. Near Santa Ines Bay, Lower California. Bott. temp. 63°. 22 fms. Fne. gy. s.

Station 3013. Near Santa Ines Bay, Lower California. Bott. temp. 65°. 14 fms. Gy. s., brk. sh.

Station 3027. Near Punta San Felipe, northern Lower California, Gulf side. Bott. temp.? 10 fms. Gy. s.

Bathymetrical range, 9.5–54 fms. Extremes of temperature, 66.6°–63°.

One hundred and twenty specimens.

Lovenia subcarinata.

Spatangus subcarinatus Gray, 1845. Eyre Voy., **1**, p. 436.
Lovenia subcarinata Gray, 1851. Ann. Mag. Nat. Hist., (2), **7**, p. 131.

The known range of this species is from southern Japan to the Aru Islands and west to the eastern coast of India. The record of its occurrence at the Hawaiian Islands is not to be trusted.

Lovenia gregalis.

Alcock, 1893. Journ. Asiat. Soc. Bengal, **62**, p. 175.

So fully has Koehler (1914. Ech. Indian Mus. Spat., p. 115–124) described and figured this species, it would be quite superfluous to add anything here, except that comparison of the ALBATROSS specimens with two of the SIBOGA specimens from near the Paternoster Islands, and with Koehler's photographs, leaves no doubt as to their identity. The range of the species is now known from southern Japan to Sumbawa and westward into the Bay of Bengal. Its bathymetrical range is noteworthy, 152–530 fms., for with the exception of *grisea*, all the other members of the genus are found in shallow water, rarely deeper than 60 fms.

Station 4906. Southwest of Koshika Islands, Japan. Bott. temp. 43.4°–42.6°. 369–406 fms. Gy. glob. oz.

Station 4912. Southwest of Koshika Islands, Japan. Bott. temp. 41.9°. 391 fms. Gy. glob. oz.

Five specimens.

Lovenia grisea.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 255.

Plate 151, fig. *5*.

Length not determinable with accuracy but less than 90 mm.; width near middle about 81 mm.; height less than 30 mm. The general form of the test is depressed heart-shape (Pl. 151, fig. *5*), the greatest width a little anterior to

the middle and the greatest height is clearly well back of the middle. The form of the petals and the tuberculation of the dorsal side is so well shown in the figure, no description is necessary. The posterior end of the specimen is so badly damaged no description of its characteristic features is possible, but a fragment containing the periproct with adjoining plates shows that the region was not at all sunken; the periproct itself is 11 mm. wide and 9 mm. high. There were at least 5 ambulacral plates (and probably more) in the subanal plastron on each side. The tuberculated portion of the sternum seems to be more extensive and the bare ambulacra wider than in *gregalis*. A fragment containing the peristome shows that it is remarkably small, only 8 mm. across and 4.5 mm. long; it is nearly flush with the surface. Most of the labrum is gone. The general color of both test and spines is gray with a slightly brownish yellow tinge.

The primary spines are all missing or broken but those of the ventral surface were certainly 15–20 mm. long at least. The secondary and miliary spines of the dorsal surface are 1–4 mm. long and very fine, almost silky. In spite of the condition of the specimen five kinds of pedicellariae were found, but unfortunately no globiferous. The rostrate, with valves, .40–.60 mm. long, and the tridentate with valves .25–.60 mm. long, are not peculiar but are much like those of other Lovenias; in the rostrate the blade is scarcely half the valve, is rather strongly curved and its width at base is about one fifth its length, while just below the tip it is twice that. Multidentate pedicellariae, with usually 7 valves rather more than a millimeter long, are present beside the ventral ambulacra. The triphyllous pedicellariae have the valves less than .12 mm. long and about .07–.08 mm. wide, so they are noticeably shorter and wider than in other Lovenias. One ophicephalous pedicellaria was found, the only pedicellaria of this sort yet recorded in the genus; the valves are short and wide, much as in Breynia (Pl. 146, fig. *31*); they measure less than .20 mm. long but the loop adds .05–.07 mm. more.

Although this species resembles *gregalis* in some important features, the differences in the shape of the test, in the tuberculation of the sternum, in the form of the petals, and in the pedicellariae serve to distinguish it without difficulty. The figure given (Pl. 151, fig. *5*) is drawn to show the composition as well as the form of the test; the sutures do not show so plainly in the specimen but they are nevertheless easily seen. Like *gregalis*, *grisea* is a deep-water species.

Station 4080. Off Puniawa Point, Maui, Hawaiian Islands. Bott. temp. 56.4°. 178–202 fms. Gy. s., for.

Lovenia triforis.

Koehler, 1914. Ech. Indian Mus. Spat., p. 124.

This species is based on a single specimen only 21.5 mm. long, from the Gulf of Martaban, Burmah, 53 fms. It was largely bare of spines and no pedicellariae were found, but there can be little question that it represents an otherwise unknown species. The genital pores seem to be fully developed and the presence of the genital glands in the corresponding interambulacra (both pore and gland being absent in interradius 2) indicates that the individual was mature in spite of its small size. Yet Lovenias seem to attain sexual maturity when still quite small. In *cordiformis*, the full-grown adult of which is 70 mm. long, the 4 genital pores are visible in a specimen only 11.5 mm. long and seem to be fully developed in specimens 20 mm. long. In very small *cordiformis*, the periproctal region is scarcely sunken at all and even in specimens 21 mm. long it is little depressed. I am inclined to think therefore that *triforis* may, when large specimens are found, prove to belong to that section of the genus, having a deeply sunken periproct.

Pseudolovenia.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 255.
Type, *Pseudolovenia hirsuta* A. Agassiz and Clark, 1907, *loc. cit.*

The justification for this genus lies in the remarkable character of the posterior ambulacra dorsally. While not apetaloid, there is no such distinction between the petal and the rest of the ambulacrum as we find in Lovenia. The anterior petals are also longer and narrower than in Lovenia but in all other respects, the two genera correspond very closely. There is as yet only one species of Pseudolovenia known.

Pseudolovenia hirsuta.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **50**, p. 255.

Plates 146, figs. *32*, *33*; 160, figs. *8–12*.

Length 60 mm.; width at apical system where widest, 51 mm.; height at apical system nearly 25 mm. The outline of the test, the depression of ambulacrum III, the position of the apical system with its four genital pores (in one specimen there are but three), the form of the petals and the tuberculation

are all so well shown in the photograph (Plate 160, fig. *10*), that a description is not needed. The internal fasciole does not show well; it encloses an area about 20 mm. long by 8 mm. wide, with a rounded posterior end; at this end the fasciole is very broad. In side view (Pl. 160, fig. 8) the somewhat swollen posterior end of the test and the projecting sternum are well seen. The ventral surface is very largely bare, as in Lovenia; the small tuberculated area of the sternum, the position and form of the peristome, and the large primary tubercles of the subanal plastron and of the lateral interambulacra all come out well in the figures (Pl. 160, figs. *9*, *12*). The posterior end of the test is nearly vertical, the periproctal region being scarcely at all depressed, though the subanal plastron projects a trifle beyond the periproct; the latter is about 9 mm. wide by 7 high. The subanal fasciole is wide and very distinct. The enclosed plastron is only 6 mm. high at the middle, but it is 25 mm. wide and at each side it is 10 mm. high; the lateral portions include 5 ambulacral plates (the 6th–10th) but there are only 3 large tube-feet; the 10th plate just sends a projecting corner within the fasciole but with no accompanying tube-foot. In all the other specimens examined, there are 4 ambulacral plates on each side within the fasciole, and 3 tube-feet, the 10th plate not entering. On each side of the plastron is a group of about 15 (holotype) large primary tubercles. The character of the sternum is well shown in fig. *9*, but the form of the labrum is not clear. Indeed the labrum shows considerable diversity in form and length. As a rule it reaches back far enough to come in contact with the third ambulacral plate on each side, but sometimes it fails entirely of reaching them. In a specimen 28 mm. long, it is 6 mm. long, 1.5 mm. wide, where widest, and tapers to a slender tip, which is broadly in contact with the third ambulacral plate on each side, while in another specimen, of about the same size, it is 5 mm. long, nearly 2 mm. wide and does not reach the third ambulacral plate on either side. The color of the smaller specimens is whitish or pale brown when dry; larger specimens are more gray or brown; the spines when dry are nearly or quite white. The subanal fasciole is dark brown, conspicuously so in alcoholic material.

The general character of the spines is clearly shown in the photographs (Pl. 160, figs. *11*, *12*). The primaries on the dorsal side are 30–35 mm. long and are very similar to those of Lovenia; under the lens the distal portion is finely thorny. Pedicellariae are abundant and characteristic. No globiferous of any sort were found, but multidentate occur about the peristome and along the sides of the ambulacra ventrally while ophicephalous are common, and in small specimens are sometimes exceedingly abundant, on the ventral ambulacra

especially at the posterior end of test. These ophicephalous pedicellariae are not peculiar in form but are remarkably small, the valves measuring only .10–.12 mm. plus .04–.06 for the loop. The triphyllous are not much smaller for their valves measure .10 mm. long by .07 mm. wide. The multidentate have 4, or more commonly 5, valves (Pl. 146, fig. *32*) which are curved inward near tip and are remarkably flat; each valve (Pl. 146, fig. *33*) is .80–.85 mm. long and about .20 mm. in width. These valves are quite different from the multidentate valves in Lovenia. Rostrate pedicellariae in Pseudolovenia are fairly common but not very distinctive. The valves are about .40–.50 mm. long, rather heavy, with the base about as wide as high, and the blade twice as wide near tip as at base, where it is about one fourth the blade-length. Tridentate pedicellariae occur in two forms but neither seems at all common. The slender tridentate have valves about a millimeter long with the strongly compressed blade .12–.15 mm. wide and nearly that in depth. The stout tridentate have wider, flatter valves, .45–.65 mm. long, approaching those of the multidentate in form.

There can be little danger of confusing the bare test of this species with that of any Lovenia, but with the spines on, specimens would easily pass for examples of that genus. Young specimens are not at all flat, like young Lovenias, but on the contrary are quite high with a tendency to have interambulacrum 5 carinate dorsally. Thus a young Pseudolovenia 24 mm. long is about 12 mm. high while a young *Lovenia cordiformis* of the same length is only about 9.5 mm. high. The decidedly anterior position of the apical system in Pseudolovenia is also a marked difference between the two genera, for in Lovenia it is but little anterior to the middle (compare Pl. 160, fig. *10* with Pl. 161, figs. *1*, *8*, *11*).

The specimens from Japanese waters are small (about 24 mm. in length), but show all the characteristic features of the genus and seem to be so similar to specimens of the same size from Hawaii, that I can find no distinguishing marks. It is true that the labrum while very slender posteriorly does not reach the third ambulacral plates, but as specimens from Hawaii show a similar condition of the labrum, this feature is not at all significant. Possibly adult specimens from Japan may show some distinctive specific characters but I find none in these two small specimens.

Station 3836. Off Lae-o Ka Laau Light, Molokai, Hawaiian Islands. Bott. temp. 48°. 238–255 fms. Br. gy. m., s.

Station 3839. Off Lae-o Ka Laau Light, Molokai, H. I. Bott. temp. 46.3°. 259–266 fms. Lt. br. m., s.

Station 3865. Off Mokuhooniki Islet, Pailolo Channel, H. I. Bott. temp. 45°–44.8°. 256–283 fms. Fne. vol. s., r.

Station 3920. Off Diamond Head Light, Oahu, H. I. Bott. temp. 44.6°. 265–280 fms. Gy. s., brk. sh.

Station 4028. Off Okula Point, Kauai, H. I. Bott. temp. 40°. 444–478 fms. Gy. s., glob.

Station 4036. Off Kawaihae Light, Hawaii, H. I. Bott. temp. 38.2°. 687–692 fms. Fne. dk. gy. s., for.

Station 4083. Off Puniawa Point, Maui, H. I. Bott. temp.? 238–253 fms. Gy. s.

Station 4122.[1] Off Barber's Point Light, Oahu, H. I. Bott. temp. 64.6°–42.3°. 192–352 fms. Fne. gy. s., m.

Station 4906. Southwest of Koshika Islands, Japan. Bott. temp. 43.4°–42.6°. 369–406 fms. Gy. glob. oz.

Bathymetrical range, 238[1]–692 fms. Extremes of temperature, 48°–38.2°.

Twenty specimens; some fragmentary.

Echinocardium.

Gray, 1825. Ann. Phil., **26**, p. 430.

Type, *Spatangus pusillus* Leske, 1778 = *Echinus cordatus* Pennant, 1777, Brit. Zool., **4**, p. 69.

I quite agree with Mortensen that Lambert's attempt to make *Spatangus atropos* Lamarck the type of this genus is lamentable and discouraging. More than that however, it is quite wrong, not at all in accordance with the International Code. Gray included three species in his genus Echinocardium (*atropos*, *pusillus*, *seba*) but *pusillus* and *seba* are identical with each other (and also with Pennant's *Echinus cordatus*). The third species *atropos* Agassiz removed to Schizaster in 1836, leaving *cordatus* alone as a possible type for Echinocardium. So recently and so well has this group been revised by Mortensen (1906. Ingolf Ech., pt. 2, p. 132–152) that there is little to add. It is necessary, as Mortensen thought likely, to revive the name *laevigaster* A. Agassiz, for the species from Florida Strait, and the following key also includes the related Japanese form, *dubium*. There are therefore eight species distinguished here as against six in Mortensen's key but my indebtedness to him is obvious.

[1] It is obvious that the lesser depth at the higher temperature was not the habitat of Pseudolovenia.

Key to the Species of Echinocardium.

Anterior ambulacrum distinctly depressed, at least at ambitus.
- Depression of ambulacrum III begins at apical system; pore-pairs of III within internal fasciole in crowded series; large tubercles in interambulacra 2 and 3 above ambitus . . . . . *cordatum.*
- Depression of ambulacrum III begins at anterior end of internal fasciole, within which pore-pairs of III are indistinct and widely separated; no large tubercles above ambitus . . . . . *mediterraneum.*

Anterior ambulacrum little or not at all depressed.
- Large primary tubercles above ambitus, at least in interambulacra 2 and 3; labrum moderate, reaching nearly or quite to end of first ambulacral plates.
  - Prominent primary tubercles above ambitus in all the interambulacra, though sometimes few . . . . . *flavescens.*
  - Primary tubercles above ambitus evident only in interambulacra 2 and 3 (sometimes a few in 1 and 4).
    - Internal fasciole large, its enclosed area about one third as long as test; little or no depression of apical region.
      - Posterior petals notably short (7 pore-pairs, with 10 in anterior petals) . . . . . *laevigaster.*
      - Posterior petals about equal to anterior (8–10 pore-pairs with 10 in anterior petals).
        - Mouth pentagonal scarcely 1.5 times as wide as long . . . . *mortenseni.*
        - Mouth reniform, twice as wide as long . . . . . *dubium.*
    - Internal fasciole very small, its enclosed area only about one fourth as long as test; a distinct saddle-shaped depression in apical region . . *capense.*
  - No large primary tubercles above ambitus in any interambulacrum; labrum very short reaching scarcely beyond middle of first ambulacral plates . . *pennatifidum.*

Echinocardium cordatum.

Echinus cordatus Pennant, 1777. Brit. Zool., **4**, p. 69.
Echinocardium cordatus Gray, 1848. Brit. Rad., p. 6.

He would be a hardy zoölogist who would maintain *australe* as a species distinct from *cordatum*. The amount of material which has now been gathered from the four quarters of the globe shows that this species is a very variable and remarkably wide-spread form. No other echinoderm can compare with it in its world-wide distribution. Mortensen speaks of it as cosmopolitan, except for the Pacific Coast of America, but there is in the M. C. Z. collection a fine specimen from Mulege Bay, Gulf of California, collected by W. J. Fisher. It is worthy of note that no specimen of Echinocardium was taken in the East Indian or Indian seas by the Siboga, Valdivia, or Investigator, yet the present species is common along the coasts of southeastern Japan and is abundant along the

coasts of New South Wales and Victoria. The only coastal regions aside from the East Indies[1] where *cordatum* is not known to occur are the western side of Africa, the southern and western parts of South America, the western coast of the United States and British North America, the southwestern coast of Asia, the northeastern shores of Africa, and the islands of the tropical Pacific. In some of these regions at least, it is very sure to be found, when the marine fauna is well worked out. The bathymetrical range is quite limited which is rather remarkable for so wide-ranging a form, but this may account for its absence from the Pacific Islands. The record in the CHALLENGER report of *australe* collected at Station 234, in 2675 fms., is undoubtedly an error,[2] as no dredging or trawling was done at that station; there is little question that the specimens were taken at Station 233, off Kobe, Japan, 12–15 fms. So far as hitherto recorded then the range of *cordatum* bathymetrically is 0–85 fms.

Station 3722. Off Yokkaichi Light, Honshu Island, Japan. Bott. temp.? 9 fms. M., s., p., sh.

Station 3723. Off Yokkaichi Light, Honshu Island, Japan. Bott. temp.? 13–16 fms. M., s., p., sh.

Station 4962. Off Tomaga Shima Light, Japan. Bott. temp.? 36 fms. Bott.? (Probably fne. gy. s., m.).

Bathymetrical range, 9–36 fms.

Ten specimens.

Echinocardium mediterraneum.

Amphidetus mediterraneus Forbes, 1844. Proc. Linn. Soc. London, 1, p. 183.
Echinocardium mediterraneum Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 44.

This species is as yet known only from the Mediterranean Sea, and from the coast of Portugal, in 1.5–23 fms.

Echinocardium flavescens.

Spatagus flavescens O. F. Müller, 1776. Zool. Dan. Prod., p. 236.
Echinocardium flavescens A. Agassiz, 1872. Rev. Ech., pt. 1, p. 110.

This species is known from Northern Norway and Iceland to the Mediterranean and doubtfully from the Azores, at depths of 5–156 fms. It is also

[1] Mr. Agassiz records in the Revision a specimen from "East India."
[2] See CHALLENGER Report. Summary of Results, p. 912 and p. 915.

recorded in the Revision from the Florida Gulf Stream, off Tennessee Reef, and Charleston, S. C., and it is indicated that specimens from those localities are in the M. C. Z. collection. The only American specimen of *flavescens* now in the M. C. Z. collection is a bare, broken test, about 38 mm. long, from Folly Island, Charleston, S. C. So far as can be judged from its present condition, it is certainly *flavescens*. I think therefore that the species is properly recorded from the American coast.

Echinocardium laevigaster.

A. Agassiz, 1869. Bull. M. C. Z., 1, p. 277.

In the Revision, Mr. Agassiz united this species with *pennatifidum* but Mortensen has suggested that it is probably distinct. The material at hand consists only of the holotype from "Florida. Pourtales coll." [1] and a fragment of an adult specimen from "off Tennessee Reef, Fla., 114 fms. Pourtales coll." The holotype is more or less bare and is now partly broken but there is no doubt that it is the original of figs. 1 and 2, plate xx of the Revision, which are there labeled *pennatifidum*. Neither on it, nor on the fragment, have I found any pedicellariae save some small tridentate which are not at all distinctive. They are much like Mortensen's fig. 44, pl. 17 (1907. Ingolf Ech., pt. 2) but the valves are less curved, the whole head being quite pyramidal. In the holotype, three plates with two large pore-pairs enter into each side of the subanal plastron. The periproct is a little wider than long but the plastron is rather longer than wide. The peristome is 8 mm. wide and 4 mm. long. The labrum is rather long, reaching the middle of the second ambulacral plate. There are many primary tubercles above the ambitus in interambulacra 2 and 3, and there seem to be one or two near the anterior edge of interambulacra 1 and 4. The area enclosed by the internal fasciole is 12 mm. long, just one third of the test length. The anterior petals are fully 12 mm. long with 10 pore-pairs in the posterior series, while the posterior petals are little more than 10 mm. long, and have only 7 pore-pairs in the posterior (inner) series. It is evident that this species is not very near *pennatifidum* but it is very near *mortenseni* and *dubium*. Further material will undoubtedly differentiate the three species more clearly, as they seem to be quite distinct.

[1] Mr. Agassiz gives the depths as 79–121 fms.

Echinocardium mortenseni.

Echinocardium intermedium Mortensen, 1907. Ingolf Ech., pt. 2, p. 143 (*preoccupied*).
Echinocardium mortenseni Thiéry, 1909. Rev. Crit. Pal., **13**, p. 137.

This interesting species, long confused with either *flavescens* or *pennatifidum*, is known as yet only from the Mediterranean Sea, where it occurs at depths of 8–23 fms.

Echinocardium dubium.

A. Agassiz and Clark, 1907. Bull. M. C. Z., **51**, p. 134.

Plate 150, figs. *1–3*.

Length 33 mm.; width, 30 mm.; height (half-way between apical system and posterior end) 20.5 mm.; height in front of apical system, 18 mm. The apical system is somewhat depressed as in *capense*. The form of the test as seen from above, the character of the tuberculation, the shape and size of the internal fasciole and the structure of ambulacra III are better shown by the figure (Pl. 150, fig. *1*) than by description. The shape of the test as seen from the rear, the form and size of periproct and of subanal plastron, the composition of the latter, and the size and form of the subanal and anal fascioles are equally comprehensible from fig. *2*. The petals, however, show much better in the specimen than in the figure; the anterior petals are slightly depressed, especially proximally, about 11 mm. long, with 9 or 10 pore-pairs in the posterior series; the posterior petals are equally depressed, less than 11 mm. long, with 8 or 9 pore-pairs in the posterior (inner) series. The peristome (Pl. 150, fig. 3) is twice as wide as long and the labrum is notable for extending backward far enough to be in broad contact on each side with ambulacral plate 2. The color of the larger specimen is yellow-brown; the smaller one is much paler.

The secondary spines of the dorsal surface are 2–3 mm. long while the primaries there are fully twice as large. On the oral surface, the primaries are 6–10 mm. in length. The primaries of the sternum are decidedly curved and markedly spatulate at tip; the widening is gradual, however, and occupies the terminal half of the spines or a little less. Very few pedicellariae were found, no doubt partly because the specimen is in poor condition. A triphyllous, with valves about .07 mm. long, resembles the same pedicellariae in *capense*. The small tridentate (or rostrate) have valves .15–.25 mm. and resemble the corresponding form in *cordatum* (see Mortensen's 1907. Ingolf Ech., pt. 2, pl. 17, fig. 21).

In the original description, it is said that this species is closely allied to *flavescens* and *pennatifidum*, "the only differences worthy of note being in the form and position of the anal system and subanal fasciole." There is reason to doubt whether these differences, in such variable features, are really constant, and I would now lay stress rather on the form and tuberculation of the test. The difference from *pennatifidum* is rather marked and the relationship with that species is not very close. The resemblance to *flavescens* is more evident but the absence of primary tubercles above the ambitus on the posterior part of the test serves to distinguish *dubium* at once. There is no doubt that *mortenseni* of the Mediterranean and *laevigaster* of Florida are the two species most closely allied to this Japanese form. But as stated above (p. 264) it is probable that more abundant material will serve to bring out the distinctions more clearly. The second of the ALBATROSS specimens of *dubium* is only 16 mm. long, but it shows all the species characters very well.

The holotype is from Station 5047. It is of interest to note that this species lives at a much greater depth than the other Japanese species of Echinocardium. Indeed, no other member of the genus is recorded from a depth greater than 150 fms.

Station 4965. Off Hiro Misaki Light, Honshu Island, Japan. Bott. temp. 49.4°. 191 fms. Dk. gn. gy. s., sh.

Station 5047. Off Kinka San Light, Honshu Island, Japan. Bott. temp. 49.6°. 107 fms. Dk. gy. s., brk. sh., p.

Two specimens.

Echinocardium capense.

Mortensen, 1907. INGOLF Ech., pt. 2, p. 137.

This species is as yet known only from the vicinity of the Cape of Good Hope, and eastward along the South African coast, at depths of 31–150 fms. It seems to be very well characterized by the remarkably small area enclosed by the internal fasciole.

Echinocardium pennatifidum.

Norman, 1867. Rept. Brit. Assoc., **37**, p. 440.

Although Mr. Agassiz gives the correct page reference to the original designation of this species, both Bell and Mortensen ignore it and refer to the publication of the following year. It may be objected that the original publi-

cation contained no adequate description, but if that is true, it is equally true of the publication in 1868; the latter contains nothing of importance not in the earlier paper, except the direct reference to Barrett's figure published in 1857, and even that is virtually given in 1867. There is no description in either report, but the information given in 1867 is sufficient to identify the species, which is a characteristic British form, known only from the Faeroe Islands and the west coast of Denmark to the Bay of Biscay, in 1–150 fms.

INDEX TO THE GENERA AND SPECIES OF HAWAIIAN AND OTHER PACIFIC ECHINI.

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EXPLANATION OF THE PLATES.

Wherever the nature of the figure permits, the anterior ambulacrum (III) is placed uppermost.

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